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NATURAL HISTORY.—*The codfishes of the Greeks and Romans.** ALFRED C. ANDREWS, University of Miami. (Communicated by LEONARD P. SCHULTZ.)

The codfish family, comprising the gadoids, is a large and important one. In it belong such fishes as the cod, the hake, the haddock, the whiting, the eglefin, the poutassou, the ling, the burbot, the dorse, the coalfish, the pollack, and the bib or pout. Some of these fishes do not occur in the Mediterranean today and therefore presumably were not familiar to the Greeks and Romans. But some are very common in that sea and must have been of considerable economic importance in ancient times.

But a scholar, whether he is an ichthyologist or a classical philologist, will look in vain for a comprehensive discussion of this family. He will find some data in notes on the names of gadoids occurring in certain works of ancient authors, some in etymological articles and reference works, and some in books that deal with classical zoology. There is a short article by Marx in an early volume of Pauly-Wissowa-Kroll-Mittelhaus on the asellus[1] and an equally brief one by Steier in a later volume of the same encyclopedia on the mustela.[2] The former is much out of date, and the two taken together deal with only a portion of the names applied to gadoids. The most valuable of recent reference works concerned with identifications is Sir D'Arcy W. Thompson's *A glossary of Greek fishes,*[3] frequently cited in this article. Its chief drawback is that the alphabetical organization of the material creates a research problem of no mean scope for a scholar who desires information about a particular family or genus of fishes, since the index is incomplete.

As matters now stand, a scholar seeking information regarding codfishes in ancient times is faced with two serious difficulties. The first is that unless he knows before he begins what names were applied or may have been applied to members of this group, he will make little progress. The second is that the meanings assigned to these names are often vague and in some cases actually erroneous.

The present article represents, so far as can be ascertained, the first attempt to treat this family of fishes as a unit, with discussion of every Greek and Latin name that was or may have been applied to gadoids. This treatment not only makes the relevant information available in convenient and readily accessible form but also it yields more precise meanings for the names themselves. This results from study of these names in relation to one another rather than as isolated terms. Consequently, the identifications of Greek fish names in particular will be found to differ frequently from those of Thompson and from those given in the *Greek-English lexicon* of Liddell-Scott-Jones.

1. MUSTELA

The mustela or "weaselfish" of the Romans has generally been identified as the cod, more particularly the 5-bearded rockling, *Gadus* (*Motella*) *mustela* Linnaeus, although the modern nomenclature suggests that ancient usage was not confined to this species.

The Mediterranean hake, *Phycis mediterraneus*

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* Received August 26, 1948.

[1] *Real-Encyclopädie der classischen Altertumswissenschaft* **2**: 1532–1533. 1896.

[2] *Idem*, **16**: 907–908. 1933.

[3] London, Oxford University Press, 1947.

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De la Roche, is known today as musdea at Pola and as musdea and musdeca at Rome[4]; and such names have earlier been reported as moustelo at Marseille (Marion), moustella bruna at Nice (Risso), mustella de scheuggio at Genoa (Sassi), musdea at Naples (Costa), and musdea di funnu in Sicily (Döderlein).[5]

The fork-beard hake, *Phycis blennioides* Bloch and Schneider, is also called musdea and musdeca at Rome,[6] and such earlier names have been reported as moustelo blanc and moustelo de roco in the Provence (Réguis), moustèle at Marseille (Brünnich), moustella blanca at Nice (Risso), mustella at Genoa (Sassi), mustià at Cagliari (Targioni), and mustea and mustià at Palermo (Döderlein).[7]

The 3-bearded rockling, *Motella tricirrata* Nilsson, is also known as musdea and musdeca at Rome, musdea at Catanzaro, and mostella at Livorno.[8] Scholars have previously reported such names as mostel at Mallorca (Barcelo), moustelo in the Provence (Réguis), moustelo at Marseille (Marion), moustella at Nice (Risso), mostella at Genoa (Targioni), musdea de funnale at Naples (A. Costa), and mustedda and mustiddu in Sicily (Rafinesque).[9]

For *Motella maculata* Günther such names have been reported as moustello at Nice (Risso) and moustelo in the Provence (Réguis).[10]

For *Motella fusca* Bonaparte such names have been reported as mostel at Mallorca (Barcelo), moustela at Nice (Risso), musdea de scoglio for the male and musdea de fangu for the female at Naples, as well as musdea de funnu (Costa).[11]

And for *Uraleptus maraldi* Costa such names have been reported as moustella negra (Risso) and moustelo negro (Réguis) at Nice.[12]

In addition, it may be noted that Larousse defines French moustèle as a generic term for *Motella* sp.

The modern names that come from mustela obviously do not apply to a single species but to several closely related ones, more especially *Phycis* sp. and *Motella* sp. This does not, however, justify an immediate conclusion that mustela in the classical era had a similarly diverse application. The history of fish names reflects a tendency for an originally limited application to spread to other closely related and similar fishes. The modern nomenclature does, however, exhibit two noteworthy features. The first is that there have been only sporadic survivals of mustela, found almost exclusively along the shores of the Tyrrhenian and Ligurian Seas, more especially at Marseille, Nice, Genoa, Rome, Naples, and Palermo. This suggests that in the classical period the use of mustela in the speech of the common people was probably largely confined to that area. The second is that these survivals do not predominate for any one species but are applied in approximately equal degree to various species of *Phycis* and *Motella*. Generally, when a name which was once narrowly restricted in application spread to other species, the survivals in modern nomenclature contain a clue to the original application. Those which are applied to other than the original species tend to be less numerous and also to be qualified in some way. Neither tendency is clearly manifest in this instance, and this gives some basis for believing that Latin mustela similarly did not refer specifically to *Gadus* (*Motella*) *mustela*, but to several closely related species, more especially *Phycis* sp. and *Motella* sp.

The mustela discussed above is the one which Ennius[13] considered superior to all other fishes when caught at Clipea and Pliny[14] ranked second only to the scarus (the parrotfish, *Scarus cretensis* Cuvier and Valenciennes) in his time, although it was esteemed chiefly for its liver. But when Pliny says that *mirum dictu* there was a mustela in the Lake of Constance which in excellence of taste compared favorably with the marine mustela, he is referring to the burbot or eelpout, *Lota vulgaris* Cuvier, which even today attains unusual excellence in the same lake. Finds at Robenhausen testify to use of this fish for food as early as the prehistoric period.[15] It has long been esteemed as a great delicacy, but more on the continent than in England. The flesh is white and delicate, the liver being the most delicious morsel.[16] This species also occurs in lakes of northern Italy, where it is known by such names as bottatrice (dial. bottris, boza) at Milan, bottratrice at Brescia, and bottatrice (dial. bosa trisa) at Verona.[17] Bottatrice is apparently a compound of botta with trische (trüsche), the second element being the more common name of this species in German Switzerland.[18] The first appearance of *lotta as a name for the burbot is in the tenth century. This is evidently a Gallic word, the source of French lotte and Spanish and Portuguese lota.[19] Ausonius[20] describes the mustela and speaks of it as occurring in the Donau and the Moselle rather than in the Lake of Constance. His mustela may also be the burbot,[21] although it has been identified by some as the lampern or lamper-eel, *Petromyzon fluviatilis* Linnaeus,[22] which is regarded by many epicures as a real delicacy. Neither identification is wholly satisfactory.[23] Columella's allusion to the voracity of the *mustela*[24] also suggests the burbot, which is a notorious fish of prey, although Thompson[25] thinks that it may be the lamprey. The burbot is a close relative of the cod and hake, classified by Linnaeus as a *Gadus*, and the tendency of the Romans to refer to it by the same name is therefore understandable.

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[4] Cf. *La pesca nei mari e nelle acque interne d'Italia*, Ministerio dell' Agricoltura e delle Foreste, Roma, Istituto Poligrafico dello Stato, **3**: 80, 84. 1931.

[5] Cf. Julius V. Carus, *Prodromus faunae mediterraneae* **2**: 575–576. Stuttgart, 1885–93.

[6] Cf. *La pesca nei mari* **3**: 80.

[7] Cf. Carus, *op. cit.*, **2**: 575.

[8] Cf. *La pesca nei mari* **3**: 83, 51, 62.

[9] Cf. Carus, *op. cit.*, **2**: 577.

[10] *Ibid.*: 578.

[11] *Ibid.*

[12] *Ibid.*: 574.

[13] *Heduph.* 1 (apud Apul. *Apol.* 39). Thompson (*op. cit.*: 169) thinks that this may be the lamprey. His identification seems to depend in part upon taking Clupea to be a fish name rather than a place name. E. H. Warmington (*Remains of Old Latin*, Loeb Classical Library, **1**: 409, note a) similarly would read *clupeis* for *Clupea* and take it as the tiny fresh-water fish described by Pliny (*N.H.* 9.44).

[14] *N.H.* 9.63.

[15] Cf. L. Rütimeyer, "Die Fauna der Pfahlbauten in der Schweiz," Neue Denkschr. allg. Schweiz. Ges. Naturw., **19**: 114. 1862.

2. Γαλῆ

Greek γαλῆ, like Latin mustela, means "weaselfish." Aristotle[26] speaks of a γαλεός with many pyloric caeca, which led Schneider to emend to γαλῆ,[27] a change approved by Hoffman.[28] This emendation was motivated by the fact that γαλεός was the usual term for a dogfish, which has no pyloric appendages, whereas the Gadidae do. That a copyist's error of this sort should have occurred is comprehensible, since γαλεός was a more common fish name than γαλῆ. It is noteworthy, moreover, that Suidas confused γαλῆ with γαλεός and that some early scholars of the modern period made the mistake of identifying the γαλῆ as a type of dogfish.

The first certain occurrence of γαλῆ is a bare mention by Epaenetus,[29] who was active about 100 B.C. Aelian,[30] who clearly distinguishes the γαλῆ from the γαλεός, says that the γαλῆ is much like the ἥπατος,[31] for it is a small fish with dull eyes, the pupils approximately dark blue. Its barbel is larger than that of the ἥπατος, he says, and smaller than that of the χρέμης; it feeds on seaweed and is a rockfish, and like the land γαλῆ (the weasel) allegedly eats the eyes of corpses it encounters. He gives Epirus as its habitat. There is no other ascertainable occurrence of the word as a fish name in the classical period. It is noteworthy that except for the single conjectural occurrence of the word in Aristotle it is not met in the literature until about 100 B.C. This circumstance suggests that it is possible that γαλῆ is a mere translation of *mustela*, which was in use at least as early as the second century B.C. and was a much more common name.

Aelian's account points to the burbot, *Lota vulgaris* Cuvier, although H. Gossen[32] maintains that it is an accurate description of the 3-bearded rockling, *Motella tricirrata* Nilsson, which is said to be good eating, although it is now little used except by the poor, since its odor a few hours after death becomes distinctly unpleasant.[33] This weakens the identification of Gossen, who incidentally fails to explain the presence of a marine species in Epirus. It is noteworthy that γάλια is the regular Modern Greek name for the burbot[34] and that this species has been known as galea in Liguria and at the northern end of the Adriatic,[35] a name which goes back to a Greek form γαλέη.[36] It should be remarked, however, that the lamprey is called γαλεή and γαλειᾶ in Modern Greek.[37]

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[16] Cf. Francis Day, *The fishes of Great Britain and Ireland* **1**: 308. 1880–84. Note *Hor. Sat.* 2.8.29.

[17] Cf. *La pesca nei mari* **3**: 70, 39, 103.

[18] Cf. Paul Barbier, "Noms de poissons, notes étymologiques et lexicographiques," Rev. Langues Romanes **56**: 181. 1913.

[19] Cf. W. Meyer-Lübke, *Romanisches etymologisches Wörterbuch*, ed. 3: 416. (Heidelberg, 1935.)

[20] *Mos.* 106 ff.

[21] It has been so identified by L. Tross, E. Böcking, and Schäfer.

[22] E.g., Gesner, Salviani, Paulus Jovius, and Francis Day.

[23] Thompson (*op. cit.*: 169) feels sure that Ausonius' account applies to the sturgeon.

[24] 8.17.8: *avidae mustelae.*

[25] *Op. cit.*: 168.

[26] *Hist. an.* 508 b 17.

[27] Cf. D'Arcy W. Thompson, *The Works of Aristotle translated into English* **4**: *Historia animalium* (Oxford, 1910), note on *loc. cit.*

[28] Cf. H. A. Hoffman and D. S. Jordan, "A Catalogue of the Fishes of Greece," Proc. Acad. Nat. Sci. Philadelphia 1892: 234.

[29] Apud Athen. 7.328.f.

[30] *Nat. an.* 15.11; cf. Plin. *N.H.* 32.53.

[31] Despite Steier, Aelian does not give ἥπατος as a synonym of γαλῆ but merely says that the γαλῆ resembles the ἥπατος. Steier is incorrect in his interpretation of Aelian's passage and overly hasty in accepting the inference of Alfred Papendick (*Die Fischnamen im griechisch-lateinischen Glossaren*: 34. Königsberg, 1926) from the equation of *mustela* with ἥπατος in *CGL* **3**: 89, 16 that γαλῆ, *mustela*, and ἥπατος are all equivalent. On the other hand, the synonymy of *mustela* and γαλῆ is attested by many lemmas in *CGL*, viz., **2**: 131, 59; 261, 16; **3**: 18, 57; 90, 69; 189, 43; 256, 65; 259, 35; 361, 70; 471, 17, as well as the form γαλέα, viz., **3**: 132, 50; 187, 16; 320, 39; 431, 46; 495, 57; 512, 61.

[32] "Die Tiernamen in Älians 17 Büchern περὶ ζῴων," Quellen und Studien Geschichte Naturw. und Medizin **4** (3) (hereafter cited as "Aelian"), par. 140. 1935; "Zoologisches bei Athenaios," *idem* **7** (2/3) (hereafter cited as "Athen."): 262. 1939.

Hesychius of Alexandria gives γάλοι as a synonym of γάδος, and Hesychius and the Lexicon of Cyrillus give γάλα as a synonym of γάδος. On the first equation Schweighäuser[38] comments that perhaps γάλοι is a corruption of γαλία, and on the second he remarks that possibly γάλα is for γαλᾶ, which would be a contraction of γαλέα. Gossen[39] emends the γάλα of Hesychius' second equation to γαλαρίας, identifying the fish as the poor-cod, *Gadus minutus* Linnaeus. This is of no value as a food fish,[40] although it is fairly common in the Mediterranean.[41] If the names which appear in Hesychius and the Lexicon of Cyrillus are actually corruptions of γαλῆ or variants of that name, γαλῆ must have been used, at least in the late period, as a synonym of γάδος, which is discussed later in this article.

Hesychius also defines γαλίαι as ὀνίσκοι, similarly identified by Gossen[42] as the poor-cod. The ὀνίσκος is discussed below.

Since the earliest certain occurrence of γαλῆ is comparatively late, since the term is found only in two technical writers of the classical period, if we exclude Aristotle, and since it survives to only a limited extent in the modern nomenclature, it is a logical inference that the term was probably not in popular use, but was merely a translation of *mustela*, as has already been suggested. We have already seen that in Aelian its use as a term for the burbot parallels one common application of *mustela*, but the application of *mustela* to the burbot almost certainly represents an extension from its marine relatives. It is therefore perhaps not pressing the meagre evidence too hard to assume that in Greek technical writers γαλῆ was used as a term for *Phycis* sp. and *Motella* sp.

3. Ἧπατος

It was pointed out above that Aelian says that the ἥπατος is very similar to the γαλῆ, which he describes as a small fish with dull eyes, the pupils approximately dark blue, with a barbel larger than that of the ἥπατος. Elsewhere[43] he describes the ἥπατος as a large, but sluggish, fish that lurks in hiding places of the sea. Aristotle describes the ἥπατος as a fish with few caeca,[44] solitary, carnivorous, with serrate teeth, black in color, with large eyes and a triangular, white heart.[45] Speusippus[46] says that it resembles the φάγρος (the braize, *Pagrus vulgaris* Cuvier and Valenciennes) and the ἐρυθρῖνος (possibly the Mediterranean barbier, *Serranus anthias* Cuvier and Valenciennes). Eubulus [47] says that it has no gall. Diocles[48] refers to it as a rockfish. Hegesander [49] states that it has two stones in its head, similar in luster and color to those found in oysters, but rhomboid in shape. Such ear stones might be found in any bony fish, but not in the shark family. Phylotimus[50] classifies the ἥπατος as a fish with soft flesh. Galen[51] says that it has flesh of intermedate consistency, despite Phylotimus. Oribasius[52] also calls it a fish with flesh of intermediate consistency, and Xenocrates says that the flesh is moderately delicate and of relatively loose texture,[53] and should not be eaten in the fall, for then it is of bad juice.[54] Marcus Sidonius[55] speaks of it as crooked-toothed. It is apparently this fish which Pliny[56] calls hepar.

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[33] Cf. Day, *op. cit.* (see note 16), **1**: 317.

[34] Cf. Thompson's note on Aristot. *Hist. an.* 508 b 17 and Hoffman-Jordan, *loc. cit.* (see note 28).

[35] Cf. P. Rolla, *Ittiologia populare*: 21. Casale, 1906.

[35] Cf. Gerhard Rohlfs, *Etymologisches Wörterbuch der unteritalienischen Gräzität*, no. 407. Halle, 1930.

[37] Cf. Thompson, *Glossary*: 168.

[38] Note on Athen. 7.315.f.

[39] "Die zoologischen Glossen im Lexikon des Hesych," Quellen und Studien Gesch. Naturw. und Medizin **7** (1) (hereafter cited as "Hesych."): nos. 338 and 341. 1937.

[40] Cf. Day, *op. cit.* (see note 16) **1**: 288.

[41] Cf. Carus, *op. cit.* (see note 5) **2**: 571.

[42] "Hesych." (see note 39), no. 345.

[43] *Nat. an.* 9.38. Thompson (*op. cit.*: 76) regards this as a different fish from the usual ἥπατος.

[44] *Hist. an.* 508 b 19.

[45] Page 306 Rose (apud Athen. 7.301.c).

[46] Apud Athen. 7.300.e.

[47] *Ibid.* 3.108.a (in Kock, *Comicorum Atticorum fragmenta* **2**: 185).

[48] *Ibid.* 7.301.c (p. 173, Wellmann).

[49] *Ibid.* 3.108.a (in Müller, *Fragmenta historicorum graecorum* **4**: 420).

[50] Apud Galen. *Alim. fac.* 3.29 (p. 368.1 Helmreich).

[51] *Alim. fac.* 3.29 (p. 370.15 Helmreich).

[52] *Coll. med.* 3.15.7.

[53] *Alim. aquat.* 10 (exc. Oribas. *Coll. med.* 2.58.-27).

[54] *Ibid.* 3.

[55] 10.

J. P. J. M. Brands[57] explains this name as a derivative of ἧπαρ, "liver," meaning literally "liverish," which seems correct, and says that the fish is unidentifiable. F. A. Wood[58] conjectured that the fish was so named because it was liver-colored. Reinhold Strömberg[59] accepts this as one possibility, calling attention (as does Wood) to ἡπατίζειν, "to be liver-colored," and ἡπατῖτις, "liver-colored," but also points out that it may have been so named because it had a large liver. He suggests that the statement of Eubulus that the fish had no gall may represent only an inference from the name. But D'Arcy W. Thompson[60] suspects that the source of ἥπατος is Egyptian abtu, a word for a fish occurring in the Book of the Dead. He considers the fish unidentified, stating that it was supposed by Belon and by Cuvier, on no valid grounds, to be the haddock or some similar gadoid fish. More specifically, Cuvier[61] identified the ἥπατος as the eglefin, *Gadus aeglefinus* Linnaeus, which does not occur in the Mediterranean.[62] Gossen[63] on the basis of Aristotle's description identifies the fish as *Molva elongata* Risso, a type of ling belonging to the gadoid family and found in the Mediterranean.

4. Λεβίας

Aristotle's description of the ἥπατος[64] is quoted by Athenaeus,[65] who gives λεβίας as a synonym of ἥπατος and cites Diocles as classifying the λεβίας as a rockfish and Speusippus as comparing it to the φάγρος (the braize). Hesychius defines λεβίας as a type of preserved fish with the scales left on, also used as a term for a type of lake fish. Aristophanes[66] lists the λεβίας along with the σκόμβρος (the common mackerel, *Scomber scomber* Linnaeus), the κολίας (the coly mackerel, *Scomber colias* Gmelin), the σαπέρδη (a type of scienid), the μύλλος (a type of scienid), and the θύννις (the common tunny, *Thynnus vulgaris* Cuvier and Valenciennes). Pollux[67] lists the same six fishes. Diphilus[68] compares the λεβίας to the σίλουρος (probably here the sheatfish, *Silurus glanis* Linnaeus) and says that both were popular among the Rhodians. Archestratus[69] speaks of buying both the λεβίας and the ἥπατος at Delos and Tenos.

Gossen[70] regards λεβίας as a mere synonym of ἥπατος and similarly identifies it as *Molva elongata*. Thompson[71] identifies the λεβίας as *Labeo niloticus* Cuvier. This may be correct in so far as the name refers to a Nile fish, but as a term for a marine fish of the Mediterranean it must have denoted a different species. In the latter sense it was identical with or very similar to the ἥπατος, and both were very much like the γαλῆ, which is almost certainly a gadoid. It is very probable, therefore, that both of these names were used as terms for one or more of the gadoids, although there is no ascertainable survival of either name in the modern nomenclature.

5. Δελκανός

Euthydemus[72] says that a fish known as the δελκανός was named after the river Delcos, where it was caught, and was very wholesome pickled in brine. Hesychius defines Delcos as a marsh in Thrace that was rich in fish. Dorion[73] says that this δελκανός was identified by some with the λεβίας. Hesychius defines λεβίας as sometimes meaning a lake fish.

Gossen[74] identifies this fresh-water δελκανός as *Barbus plebeius* Valenciennes, a small barbel which occurs in both the Italian and the Balkan lakes and rivers. It has already been pointed out that mustela certainly and γαλῆ probably were applied not only to certain marine gadoids, but also the the fresh-water burbot, *Lota vulgaris* Cuvier. It seems very likely that both the δελκανός and the lake λεβίας were also the burbot.

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[56] *N.H.* 32.149.

[57] *Grieksche Diernamen*: 156. Purmerend, 1935.

[58] "Greek Fish Names," Amer. Journ. Philol. **49**: 49. 1928.

[59] "Studien zur Etymologie und Bildung der griechischen Fischnamen," Göteborgs Högskolas Årsskr. **49**: 45. 1943.

[60] *Op. cit.*: 76.

[61] Cuvier et Valenciennes, *Histoire naturelle des poissons* **2**: 232. Paris, 1828–49.

[62] Cf. Day, *op. cit.* (see note 16) **1**: 283.

[63] "Aelian" (see note 32), par. 140; "Athen." (see note 32): 261.

[64] Page 306 Rose.

[65] 7.301.c.

[66] Apud Athen. 3.118.c (in Kock, *Comicorum Atticorum fragmenta* **1**: 499).

[67] 6.48.

[68] Apud Athen. 4.132.d (in Kock, *op. cit.* **2**: 545).

[69] *Ib.* 7.301.d (frg. 30 Ribbeck; frg. 27 Brandt).

[70] "Athen." (see note 32): 261.

[71] *Op. cit.*: 9, 146; cf. "On Egyptian Fish Names Used by Greek Writers," Journ. Egyptian Archaeol. **14**: 23–24. 1928.

[72] Apud Athen. 3.118.b.

[73] *Ibid.*

[74] "Hesych." (see note 39), nos. 427 and 1259; "Athen." (see note 32): 240.

6. Πρέπων

Oppian[75] speaks briefly of the *πρέπών* as a fish which lurks in lairs in the depths of the sea and, being large and powerful in body, but somewhat sluggish in movement, lies in wait for smaller fish. Aelian[76] describes the fish in almost identical terms. Suidas says that *πρέπων* and *πρόβατον* were alternative terms for a very large fish known as *ὕπατος*. The fish is also mentioned by Marcus Sidonius.[77] The description of the fish, the fact that Suidas identifies it with the *ὕπατος* (properly *ἥπατος*?), and the fact that Aelian describes the *ἥπατος* in almost identical language in the same passage suggest that this is one of the Gadidae.[78]

7. Πρόβατον

The *πρόβατον*, or "sheepfish," is described in precisely the same terms as the *πρέπων* by both Oppian[79] and Aelian,[80] except that the former[81] also says that when hooked it often escaped by merely becoming a dead weight on the line, sinking to the bottom. Although Suidas regarded *πρέπων* and *πρόβατον* as synonymous, both Oppian and Aelian clearly considered them different fish. Rondelet reported that the umbra (one of the scienids) was called "sea-sheep" by the Greeks in his day. Belon thought that the fish might be *Merlangus poutassou.* Mair[82] identifies it merely as one of the Gadidae. Gossen[83] calls it specifically *Merluccius vulgaris* Fleming. Thompson[84] regards it as unidentified.

8. Ὄνος

Ancient sources yield much more information regarding the *ὄνος* or "assfish." Aristotle[85] says that some fishes hide in the sand and some in the mud, but the majority hide only during the winter, crustaceans, rockfishes, rays, and cartilaginous fishes hiding only during extremely severe weather, as is evident from the fact that they are not caught when the weather is extremely cold. But some fishes hide in summer, for example, the *γλαῦκος* (unidentified), which hides in summer for about 60 days. The *ὄνος* and the *χρύσοφρυς* (the gilt-head, *Chrysophrys aurata* Cuvier and Valenciennes) also hide in summer, and that the *ὄνος* hides for a long period may be inferred from the fact that there is a long period when it is not caught. Oppian[86] also comments on the fact that the *ὄνος* stays in hiding during the heat of summer. Aristotle also says[87] that the *ὄνος*, the *βάτος* (the skate, *Raja* sp.), the *ψῆττα* (the plaice, *Pleuronectes* sp.), and the *ῥίνη* (the angel-shark, *Rhina squatina* Rafinesque) burrow in the sand, and after concealing themselves angle with the filaments that they have in their mouths, which fishermen call their fishing rods. In Pliny's rendering of this passage[88] there is no reference to the *ὄνος*. Athenaeus[89] quotes Aristotle as saying that the *ὄνος*, like sharks and dogfishes (*γαλεοί*), has a widely gaping mouth and is not gregarious. It is the only fish that has its heart in its stomach,[90] and in its brain it has stones resembling millstones. It is also the only fish that lives in holes during the hottest dogdays, all the others going into hiding during the severest winter weather. Aristotle[91] in a dubious passage says that it angles like the *βάτραχος* (the fishing frog, *Lophius piscatorius* Linnaeus). Epicharmus[92] refers to the stomach of the *ὄνος* as extraordinary.[93] Aelian[94] also says that the *ὄνος* is not gregarious and is the only fish that has its heart in its stomach and has stones in its head resembling millstones, being also the only fish to go into hiding in the dogdays, all the others hiding only in the severest winter weather. Oppian speaks of the *ὄνος* as a very large fish that sinks to the bottom when hooked, instead of fighting, and by sheer weight often breaks the line and gets free,[95] and gives the deep sea as its habitat.[96] Phylotimus[97] lists the *ὄνος* among the soft-fleshed fishes.

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[75] *Hal.* 1.146 ff.

[76] *Nat. an.* 9.38.

[77] 8.

[78] Cf. Mair, note on Oppian. *loc. cit.* Gossen ("Aelian" [see note 32], par. 140) says that it is probably the coalfish, *Gadus virens* Linnaeus, which is rare in the Mediterranean. Thompson (*op. cit.*, p. 218) states only that it is an unknown, large, deep-sea fish. Strömberg (*op. cit.* [see note 59]: 33) regards *πρέπων* as a present participle of *πρέπω*, "shine forth," hence "excellent," "that which is suitable (for eating)," and infers from Aelian that the term belonged to the fishermen's patois.

[79] *Loc. cit.*

[80] *Loc. cit.*

[81] *Hal.* 3.139 ff.

[82] *Loc. cit.*

[83] *Loc. cit.*

[84] *Op. cit.*: 220.

[85] *Hist. an.* 599 b 26 ff.

[86] *Hal.* 1.151 ff.

[87] *Hist. an.* 620 b 29 ff.

[88] *N.H.* 9.144.

[89] 7.315.e (p. 311 Rose).

[90] Cf. Aelian. *Nat. an.* 5.20.

[91] *Hist. an.* 620 b 30.

[92] Apud Athen. 7.315.f (in Kaibel, *Comicorum graecorum fragmenta*: 102).

[93] Thompson (*op. cit.*: 183) comments that the "paunch" is not especially large, the saying arising perhaps from the fact that the large swim bladder is apt to force the stomach out of the mouth when hake or cod are pulled up from deep water.

[94] *Nat. an.* 6.30.

This is all the useful information regarding the *ὄνος* obtainable from ancient sources, and most of it clearly stems from Aristotle. The modern nomenclature is not helpful, for *ὄνος* has been largely replaced by names based on *γάδος*. Bussemaker and Cresswell identified the *ὄνος* as the cod, *Gadus mustela* Linnaeus; Cuvier and Littré, as the 3-bearded rockling, *Motella tricirrata* Nilsson; and C. D. Badham[98] thought that it might be the sea-tench or Mediterranean hake, *Phycis mediterraneus* De la Roche, which he says has a barbel and a large head and is the only gadoid with barbels frequenting southern seas. Camus[99] identified it as the eglefin, *Gadus aeglefinus* Linnaeus, which does not occur in the Mediterranean.[100] Gossen [101] identifies it as the bib or pout, *Gadus luscus* Linnaeus, which is only a wanderer in the Mediterranean, stragglers being taken as far to the east as Italy, but almost never as far as Greece.[102] Brands[103] goes no farther than to say that it is one of the Gadidae. The *ὄνος* has generally been identified as the common hake, *Merluccius vulgaris* Cuvier,[104] which occurs in the Mediterranean, especially along the northern shores, and in the Adriatic, and has coarse flesh that may be cut into steaks and fried or cooked in pies.[105] If the text of Aristotle is correct, it should be referred rather to the Mediterranean hake, *Phycis mediterraneus* De la Roche, and the fork-beard hake, *Phycis blennioides* Bloch and Schneider,[106] both of which are common in the Mediterranean.[107]

9. Ὀνίσκος

With regard to the *ὀνίσκος*, the chief problem is whether or not it is identical with the *ὄνος*, of which this is a diminutive form. Oppian, to judge from the data he gives, considered them different fishes; and Dorion[108] definitely differentiates the two; but Galen[109] says that what Phylotimus called *ὄνος* others called *ὀνίσκος*; and Eustathius[110] and Hesychius give *ὀνίσκος* as a synonym of *ὄνος*. The *ὀνίσκος* was certainly closely related to the *ὄνος*, if it was not identical with it. It was a white fish[111] that lived in the sea,[112] feeding in the mud and the shallows.[113] It was not a rockfish, although its flesh was of equal firmness, according to Galen.[114] On the other hand, Xenocrates[115] speaks of the flesh as of intermediate consistency, and Oribasius[116] refers to it as soft, but not particularly friable, and devoid of excrementitious humors. Xenocrates also states[117] that the flesh is not acrid, is of good juice, difficult to assimilate, easy to pass, and nourishing. Since it was used as bait for the tunny,[118] the *ὀνίσκος* could not have been a very large fish. Oribasius[119] mentions a freshwater type. The marine type was considered unsuitable for salting.[120]

Barbier[121] identifies the *ὀνίσκος* with the *ὄνος* and refers it likewise to the common hake, *Merluccius vulgaris* Cuvier. Bussemaker distinguished it from the *ὄνος* and identified it as the common whiting, *Gadus merlangus* Linnaeus (*Merlangus vulgaris* Fleming). Thompson[122] believes that the *ὀνίσκος* is probably one of the lesser species of the cod family, perhaps the poutassou, *Merlangus poutassou* Risso, the 3-

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[95] *Hal.* 3.138 ff.

[96] *Ibid.* 1.151.

[97] Apud Galen. *Alim. fac.* 3.29 (p. 368.1 Helmreich).

[98] *Prose halieutics, or ancient and modern fish tattle*: 353. London, 1854.

[99] *Histoire des animaux d'Aristote, avec la traduction française* **2**: 84. Paris, 1783.

[100] Cf. Day, *op. cit.* (see note 16) **1**: 283.

[101] "Hesych." (see note 39), nos. 338 and 1557; "Aelian" (see note 32), par. 140; "Athen." (see note 32): 261.

[102] Cf. Day, *op. cit.* (see note 16) **1**: 286; Carus, *op. cit.* (see note 5) **2**: 572.

[103] *Op. cit.*: 171.

[104] Cf. Mair's ed. of Oppian, introd.: lxv; Paul Barbier, "Noms de poissons," Rev. Langues Romanes **53**: 27. 1910.

[105] Cf. Day, *op. cit.* (see note 16) **1**: 300.

[106] Cf. Thompson, note on Aristot. *Hist. an.* 599 b 34; *Glossary:* 182; Mair, *loc. cit.*

[107] Cf. Day, *op. cit.* (see note 16) **1**: 303; Carus, *op. cit.* (see note 5) **2**: 575.

[108] Apud Athen. 7.315.f.

[109] *Alim. fac.* 3.29 (p. 368.21 Helmreich).

[110] Page 862.

[111] Marc. Sid. 11.

[112] Galen. *Alim. fac.* 3.40 (p. 384.18 Helmreich); *De bon. mal. suc.* 3 (p. 397.1 Helmreich).

[113] Oppian. *Hal.* 1.105.

[114] *De bon. mal. suc.* 9 (p. 417.24 Helmreich).

[115] *Alim. aquat.* 1.

[116] *Coll. med.* 3.2.11; 4.1.37.

[117] *Alim. aquat.* 14.

[118] Oppian. *Hal.* 3.191.

[119] *Coll. med.* 3.15.5.

[120] Galen. *Alim. fac.* 3.40 (p. 384.18 Helmreich); Oribas. *Coll. med.* 4.1.37.

[121] *Loc. cit.* (see note 104).

[122] *Glossary*: 181–182.

bearded rockling, *Motella tricirrata* Nilsson, or the poor-cod, *Gadus minutus* Linnaeus. The common whiting has been much esteemed as a food fish, more so perhaps than any other species of the genus, being very easy to digest except in April, May, and June, when it is out of condition and may cause nausea and even vomiting. It is best eaten immediately after capture, since it decomposes rapidly. When the takes exceed the demand, whitings are often salted or dried.[123] Since the marine ὀνίσκος was not suited for salting, it is probably not the common whiting. Another significant point casting doubt on the common whiting is that such physicians as Galen, Xenocrates, and Oribasius would almost certainly have commented on the dangers of eating it out of season. In addition, the common whiting is rare in the Mediterranean,[124] and it is clear that the ὀνίσκος was very common. Gossen regards the equation of ὄνος with ὀνίσκος as an outright error[125] and like Thompson suggests that the ὀνίσκος may be the poor-cod.[126] But this is a very dubious identification, since the poor-cod is practically worthless as a food fish,[127] and Xenocrates comments favorably on the dietetic qualities of the ὀνίσκος. If the ὀνίσκος was not identical with the ὄνος, it was certainly very similar to it, and identification of this fish as the common hake is therefore very plausible.

10. Ὀνίας

Brands[128] cites ὀνίας as a fish name used by Dorion[129] and Oppian,[130] identifying it as one of the Gadidae. Actually, in the cited passages Dorion uses ὄνος and Oppian ὀνίσκος, and if Brands had delved a little deeper, he would not so readily have acknowledged himself unable to explain the extension of ὄνος, "ass," to a fish. Nicander of Thyateira[131] says that there are two kinds of σκάρος, one of which is the ὀνίας and the other the αἴολος. Hesychius also defines ὀνίας as a type of σκάρος. The σκάρος, as has already been pointed out, is the parrotfish, *Scarus cretensis* Cuvier and Valenciennes. Αἴολος is not a fish name, but a descriptive epithet, probably alluding to the shimmering gleam of the scales of a freshly caught fish[132]; and it was applied to varied fishes, such as the πέρκη (the sea-perch, *Serranus scriba* Cuvier and Valenciennes),[133] the μόρμυρος (one of the sea-breams, probably *Pagellus mormyrus* Cuvier and Valenciennes),[134] the σάλπη (the saupe, *Box salpa* Cuvier and Valenciennes),[135] and the κορακῖνος (one of the scienids, probably *Corvina nigra* Cuvier and Valenciennes).[136] Clearly, therefore, ὀνίας was a descriptive epithet, alluding in the case of the σκάρος to a dull, ass-gray type; and ὄνος and ὀνίσκος were applied to certain gadoids because of their ass-gray coloration.[137] Identification of the ὀνίας of Nicander as perhaps *Smaris vulgaris* in the *Greek-English lexicon* of Liddell-Scott-Jones assuredly has slight justification.

11. Καλλαρίας

Another Greek fish name which apparently belongs in the gadoid group is notable for the variety of forms in which it occurs. Oppian[138] uses the form καλλαρίας and differentiates this fish from the ὀνίσκος, mentioning that it also frequents muddy shallows. Archestratus[139] identifies the καλλαρίας with the ὄνος. Dorion speaks of the γαλλαρίας as a type of ὀνίσκος with one spiny fin, like the river μύραινα,[140] says that the γαλλεϱίας[141] was also called ὀνίσκος,[142] and gives both χελλαριίης and ὀνίσκος as synonyms for μύλλος (usually a type of scienid).[143] Euthydemus[144] identifies the γελαρίης[145] with the ὀνίσκος and the βάκχος. Hesychius identifies the γαλαρίας with the ὀνίσκος. He also gives χελιδών and χελιδονίας as synonyms of χελεάρ and says that χελεάρ also denoted a kind of fish.

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[123] Cf. Day, *op. cit.* (see note 16) **1**: 290.

[124] Cf. Carus, *op. cit.* (see note 5) **2**: 571.

[125] "Hesych." (see note 39), no. 1557.

[126] *Loc. cit.* and no. 213.

[127] Cf. Day, *op. cit.* (see note 16) **1**: 288.

[128] *Op. cit.* (see note 57), p. 171.

[129] Apud Athen. 7.315.f.

[130] *Hal.* 3.191.

[131] Apud Athen. 7.320.c.

[132] Cf. Léon Lacroix, "Notes critiques à Athénée, Épithètes et noms de poissons dans un vers de Numenius (Athen. 7.326.a)," Mélanges Desrousseaux: 256, note 2. Paris, 1937. Strömberg (*op. cit.* [see note 59]: 23) thinks that the word also alluded to the quick and lively movement of those fishes to which it was applied, but this is not consistent with the actual applications.

[133] Epicharm. frg. 47.48 Kaibel (*Comicorum graecorum fragmenta*).

[134] Oppian. *Hal.* 1.100.

[135] *Ib.* 1.125.

[136] Numen. apud Athen. 7.308.e.

[137] Strömberg (*op. cit.* [see note 59]: 100), accepting the gray coloration as the basic reason for the application of these names, points out that a fish with a large head would be regarded as stupid and obstinate and might therefore be called "assfish."

[138] *Hal.* 1.105.

[139] Apud Athen. 7.316.a (frg. 35 Ribbeck, frg. 14 Brandt).

[140] *Ibid.* 7.312.d Μύραινα generally denoted the moray, *Muraena helena* Linnaeus, while the European fresh-water eel, *Anguilla vulgaris* Turton, was known as ἔγχελυς, and the conger eel, *Conger vulgaris* Cuvier, as γόγγρος. There is no fresh-water type of moray, and Dorion's river μύραινα must therefore be a different fish. There is, moreover, in the region known to Dorion, no fresh-water fish similar to the moray with one spiny fin, and he was familiar with the use of ἔγχελυς as a term for the fresh-water eel. By elimination, accordingly, Dorion may have had in mind the burbot, *Lota vulgaris* Cuvier, or the lamper eel, *Petro-*

Strömberg[146] thinks that the form χελλαρίης may have arisen through folk etymology by a crossing of καλλαρίης with χελ(λ)ών, "gray mullet." In the case of forms beginning with γαλ- he suspects the influence of the generic term γαλεός (shark or dogfish). He suggests that γαλλερίας arose from γαλεός by the influence of ἀστερίας (perhaps the smooth dogfish, *Mustelus vulgaris* Müller). Neither explanation is especially convincing, for Strömberg starts from the dubious hypothesis that γαλεός and γαλῆ are really variants of the same word and that therefore people were inclined to associate sharks and dogfishes with the gadoids. Gossen[147] calls χελεάρ a Laconian word which is either equivalent to χελιδονίας and in that case possibly denotes *Luvarus imperialis* Rafinesque,[148] or is equivalent to χελλαρίας and in that case is synonymous with ὀνίσκος and denotes the poor-cod, *Gadus minutus* Linnaeus. Thompson[149] is also inclined to read χελλαρίης for χελεάρ, making it synonymous with ὀνίσκος. Hesychius also gives γάλα and ὄξος as synonyms of γάλος, and Gossen[150] here emends to γαλαρίας and ὄνος. In still another definition Hesychius gives καλαρίας as a synonym of λαζίνης. Pliny[151] classifies the collyri (emended by some to callariae) as a smaller type of asellus. Since he identifies the bacchus as a type of asellus caught only in deep water and therefore preferred to the collyrus, the collyrus obviously must have been caught in shallow water. Collyrus is certainly a transliteration of some Greek name for one of the gadoids, possibly *κολλυρίας, a conjectural variant of the name here discussed.

Since there are almost no descriptive clues, identification in this case must depend almost solely upon the equations made in ancient sources, and these are not entirely in harmony. They do indicate that the name must have denoted a fish very similar to or identical with the ὄνος or the ὀνίσκος, which would make it a type of cod or hake. As mentioned above, Gossen believes that χελεάρ if equivalent to χελλαρίας is a synonym of ὀνίσκος and denotes the poor-cod, *Gadus minutus* Linnaeus. He also so identifies the γαλαρίας.[152] Other scholars have similarly identified this fish name.[153] But when the name is used as a synonym of γάδος, or as a synonym of λαζίνης, also called χαραδρίας, Gossen refers it to *Gadus luscus* Linnaeus[154]. Brands[155] says that the name is not identifiable. Neither *Gadus luscus* nor *Gadus minutus* is a very plausible identification. As has already been pointed out, the latter is practically worthless as a food fish, and the former is only a wanderer in the Mediterranean, almost never being caught as far to the east as Greece. It is difficult to see how it is possible to restrict the meaning any further than to say that this fish is apparently a type of cod or hake, although Thompson[156] thinks that it is probably the common hake, *Merluccius vulgaris* Cuvier.

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myzon fluviatilis Linnaeus. Of these two, the latter is a somewhat more plausible identification, first because there are some Greek fish names, presumably known to Dorion, which apparently were applied to the burbot, whereas no Greek fish name can with assurance be referred to the lamper eel, and second because there was a marked tendency to confuse the lamper eel with the moray (cf. Thompson, *op. cit.*: 164). Gossen ("Athen." [see note 32]: 246) says that Dorion's μύραινα is certainly the Kurzschwanzaale (by which he apparently means the suborder Symbranchii) and asserts that the scholarly Dorion is the only one to report that it has only one bone (Gräte). This supposition borders on fantasy. The Symbranchii do not resemble the moray, but the eel, and they do not occur in streams emptying into the Mediterranean. Moreover, the ἄκανθα to which Dorion alludes is almost certainly a prominent fin ray, not a bone. As for the γαλλαρίας with one spiny fin, it may be noted that *Motella* sp. has two dorsal fins, the anterior of which is reduced to a narrow, rayed fringe, more or less concealed in the longitudinal groove, and the first ray of this anterior fin is prolonged.

[141] Sic Meineke; γαλλερίδας AC.

[142] Apud Athen. 7.315.f.

[143] *Ibid.* 3.118.c.

[144] *Ib.* 7.315.f.

[145] Sic A; γαλλερίης C.

[146] *Op. cit.* (see note 59): 130.

[147] "Hesych." (see note 39), no. 2296.

[148] The χελιδονίας, or "swallowfish," of the Greeks is probably the flying gurnard, *Dactylopterus volitans* Cuvier and Valenciennes.

[149] *Op. cit.*: 285.

[150] "Hesych." (see note 39), no. 338.

[151] *N.H.* 9.61 and 32.146.

[152] "Hesych." (see note 39), no. 341.

[153] Cf., e.g., Külb in August Steier, *Aristoteles und Plinius zur Geschichte der Zoologie*: 82. Würzburg, 1913.

[154] "Hesych." (see note 39), nos. 338 and 1236.

[155] *Op. cit.* (see note 57): 159.

[156] *Op. cit.*: 97.

12. Λαζίνης

So far as can be ascertained, the only occurrence of λαζίνης as a fish name is in Hesychius, who says that it denoted the χαραδρίας and the fish καλαρίας.[157] As a fish name, λαζίνης probably represents an extension from a type of plover.[158] It may be a gadoid.

13. Ὄξος

Likewise, the ὄξος which Hesychius gives as a synonym of γάδος is apparently the only occurrence of this word as a fish name, and Gossen's emendation to ὄνος is therefore plausible, more especially since there is no logical explanation for the application of this word to a fish.

14. GALAXIAS

There is another fish name which bears a close resemblance to καλλαρίας and its variants. Phylotimus[159] lists the γαλεώνυμος among fishes with hard flesh. Oribasius[160] says that this fish is of bad juice and difficult to digest. Galen[161] says that there is more than a single kind of γαλεός, and that one type, which brought a very high market price among the Romans, was called γαλαξίας[162] by them, but either γαλεός or γαλεώνυμος by the Greeks. He also says that it was a fish with soft flesh, although the other γαλεόι had hard flesh, and that Phylotimus probably fell into error on this point because the fish apparently did not occur in the Greek sea and he was therefore not personally acquainted with it.

Strömberg[163] says that the form γαλεώνυμος almost certainly arose by a blending of γαλεός and καλιώνυμος (*sic*). The latter, he says, is the name of a fish of prey that was called λύκος and properly means "with a beautiful name," being a typical example of the application of a flattering name to a ferocious fish for the purpose of winning its goodwill. But καλλιώνυμος apparently was not the name of a fish of prey, but of the scabbardfish, *Uranoscopus scaber* Linnaeus, which was ironically called by this name because it was so ugly. Its byname, moreover, was not λύκος, "wolf," but λύχνος, "lamp," possibly applied to it because it was active at night. With regard to γαλαξίας, Strömberg, who takes this to be a Greek term, despite the explicit statement of Galen, suggests that it is perhaps a corrupt derivative of γαλεός, influenced by a word in -αξιας, such as ταραξίας. This hypothesis has little to recommend it.

The account of Galen suggests a type of shark or dogfish, but no shark or dogfish is known to have been present in Italian but not in Greek waters. A second possibility is that it may have been a type of sturgeon. On the other hand, it is barely possible that Galen, even though he was personally acquainted with the fish, thought that its Greek name was γαλεός, whereas it was actually γαλῆ, a name which does not occur in his extant works. As has been mentioned before, others lapsed into error on the same point. In that event, the galaxias is probably a gadoid. Furthermore, if galaxias is synonymous with γαλῆ, it is also synonymous with mustela, which would make it a term for *Phycis* sp. and *Motella* sp. Pliny ranked the mustela second only to the parrotfish in his time, and Galen comments on the unusually high market price of the galaxias.

15. Βάκχος

Still another Greek fish name which belongs in this group is βάκχος. Euthydemus[164] makes it synonymous with γελαρίης and ὀνίσκος. Eustathius[165] gives it as a synonym of ὄνος and ὀνίσκος. Xenocrates[166] classifies it as a fish with flesh of intermediate consistency, and Diphilus of Siphnos[167] considered it of good and abundant juice and nourishing. Pliny[168] classifies the bacchus as a type of asellus caught only in the deep sea and therefore preferred to the collyri. The difficulties in this case are aggravated by the fact that βάκχος not only must have denoted a type of gadoid but was used as an alternative term for the μύλλος (usually one of the scienids), like χελλαρίης and ὀνίσκος,[169] and also denoted a type of gray mullet, possibly *Mugil saliens*

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[157] Thompson (*op. cit.*: 144) would read καλλαρίας for καλαρίας and χελλαρίας for χαραδρίας. Coray emended λαζίνης to μάζινος, discussed subsequently in my text.

[158] Cf. Brands. *loc. cit.*

[159] Apud Galen. *Alim. fac.* 3.30.1 (p. 372.5 Helmreich).

[160] *Coll. med.* 3.16.9 and 3.18.9.

[161] *Alim. fac.* 3.31 (p. 372.18 Helmreich).

[162] γαλαξίας AB; γαλεξίας V. Note *CGL* **3**: 241, 37: δ γαλαξίας galaxias.

[163] *Op. cit.* (see note 59): 108–109.

[164] Apud Athen. 7.315.f.

[165] Page 862.

[166] *Alim. aquat.* 1.

[167] Apud Athen. 7.356.b.

[168] *N.H.* 9.61 and 32.145.

[169] Cf. Dorion apud Athen. 3.118.c.

Risso.[170] The name clearly was applied to several different fishes, and identification of the gadoid to which it was sometimes applied would be simpler if the common characteristic responsible for the application of this name to such different fishes were known. The most attractive guess is that it was the gray coloration.

Although the *βάκχος* has been identified as the common hake, *Merluccius vulgaris* Cuvier,[171] and as the poor-cod, *Gadus minutus* Linnaeus,[172] the evidence is too scant to justify identifying it any more specifically than as a type of cod or hake similar to or identical with the *ὄνος* and the *ὀνίσκος*.

16. Μάξεινος

Dorion[173] gives *μάξεινος*[174] as a synonym of *γαλλερίας* and *ὀνίσκος*. Epicharmus[175] refers to *μάζοι* and Hesychius to *μαζίναι*. Xenocrates[176] gives *μαζέας* as a synonym of *ἥπατος*, stating that the flesh is rather delicate and of loose texture, lacking compactness. Theophrastus[177] compares the *μαζίνης* to an Indian fish which went out upon dry land. *Μύξον*, which may possibly have some connection with these variants, generally denoted a type of gray mullet, perhaps *Mugil auratus* Risso or *Mugil saliens* Risso.[178] Dorion apparently regarded *μάξεινος* as a term for a type of cod or hake, and it is perhaps of some significance that the bib or pout, *Gadus luscus* Linnaeus, is called mazzia today at Catanzaro.[179] One major objection to this identification is that the bib, as has already been mentioned, is only a wanderer in the Mediterranean and is almost never caught as far east as Greece. Thompson[180] says that since a fish with similar habits is compared to the goby by Theophrastus in the same passage, and since one of the Sicilian vernacular names for the goby is mazzono, *μαζίνης* may be, *inter alia*, a goby name, although these fish names, in so far as they relate to *ἥπατος*, *γαλλερίας*, and *ὀνίσκος*, point to some member of the cod family.

17. Γάδος

Dorion[181] makes *γάδος* synonymous with *ὄνος*, while Hesychius says that the *γάδος* was called *γάλα* and sometimes *ὄξος*, emended by Gossen[182] to *γαλαρίας* and *ὄνος*. In the Lexicon of Cyrillus *γάλα* is also given as a synonym of *γάδος*.

The origin of this name is obscure.[183] The term *γάδαρος*, "ass," which appears in Diogenianus,[184] looks like a derivative, as does *γαϊδάριον*, "ass," which occurs in an Amherst Papyrus of the VI/VII century. These forms have the appearance of an intermediate stage in the development of Modern Greek *γαϊδαρόψαρον*, "donkeyfish," the usual name of the poutassou, *Pollachius poutassou* Bonaparte (*Merlangus poutassou* Risso),[185] also known as *γαδούψαρον*.[186] This species, while common in most of the Mediterranean, becomes rare in the Italian seas; it has flesh of good taste, but soft, and decomposes rapidly.[187] The common hake, *Merluccius vulgaris* Cuvier, is called *γαδείψαρον* on Crete,[188] and according to Mair[189] is known as *γάδος* in Greece, although a loan word from Turkish *μπακάλης*, "grocer," seems to be in more common use, in the form *μπακαλάρο* or *μπακαλιάρος*, also written *βακαλάος* and *βακάλης*.[190] Gossen,[191] identifying the *γάδος* with the *γαλαρίας* and the *ὄνος*, refers it to the bib, *Gadus luscus* Linnaeus, an implausible identification, as has already been pointed out.

18. Χρέμης

Hesychius gives *χρέμυς* as a synonym of *ὀνίσκος*. Whether *χρέμυς* and the variants χρέμης, χρέμις, and χρέμψ should be regarded as distinct from χρόμις, χρόμιος, and χρόμυς is debatable. Brands[192] maintains that χρόμις, together with χρέμης and χρέμυς, is related to χρεμετίζειν, "neigh," and χρόμος, defined by Hesychius as "a kind of noise," to which can be added χρόμαδος, "a grating, creaking sound." He explains χρόμις as meaning "gnasher," applied to the fish because it uttered a sound. Strömberg[193] accepts Brands' etymology of χρόμις and χρόμης, suggesting that the variant χρέμυς may have arisen by contamination of χέλυς, "turtle." But he thinks that χρέμψ may be a retrograde formation from χρέμπτεσθαι, "to clear one's throat."

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[170] Cf. Hicesius apud Athen. 7.306.e; Plin. *N.H.* 32.77.

[171] Cf. Külb in Steier, *op. cit.* (see note 153): 82.

[172] Cf. Gossen, "Hesych." (see note 39), no. 213; "Athen." (see note 32): 261.

[173] Apud Athen. 7.315.f.

[174] Sic A; *μυξῖνος* C.

[175] Apud Athen. 7.322.b (in Kaibel, *Comicorum graecorum fragmenta*: 103).

[176] *Alim. aquat.* 10 (exc. Oribas. *Coll. med.* 2.58.27). *Μαζέας* is feminine in E and Gesner, masculine in E 2ªm, *ἡμαζέας* in ABC, *ἡμαζέας* in MNV.

[177] Frg. 171 Wimmer (apud Athen. 8.332.b).

[178] Cf. Aristot. *Hist. an.* 543 b 14; 570 b 2; Hices. apud Athen. 7.306.e; Diphil. *ib.* 8.356.d.

[179] Cf. *La pesca nei mari* (see note 4) **3**: 50.

[180] *Op. cit.*: 152–153.

[181] Apud Athen. 7.315.f.

[182] "Hesych." (see note 39), no. 338.

[183] According to Wharton (*Etyma graeca*, s.v.), it is of Semitic origin; but according to Muss-Arnold (Trans. Amer. Philol. Assoc. **23**: 102. 1892), this is very doubtful.

[184] 5.36.

[185] Cf. Hoffman-Jordan, *op. cit.* (see note 28): 276; N. C. Apostolidès, *La pêche en Grèce*, ed. 2: 29. Athens, 1907.

[186] Cf. D. Bikélas, "Sur la nomenclature moderne de la faune grecque," Ann. Assoc. Encourag. Études Grecques **12**: 227. 1878.

[187] Cf. Day, *op. cit.* (see note 16) **1**: 292.

[188] Cf. Badham, *op. cit.* (see note 98): 352.

[189] Introd. of his ed. of Oppian: lxv.

[190] Cf. Apostolidès, *loc. cit.* (see note 185); Hoffman-Jordan, *op. cit.* (see note 28): 277.

[191] "Hesych." (see note 39), no. 338.

Aristotle speaks of the sharp hearing of the χρόμις[194] and of the grunting sound it makes,[195] classifies it as a shoal fish that spawns once a year,[196] and mentions the otolith it has in its head.[197] Pliny[198] speaks of the flashing gleam of the chromis in the water, and Ovid[199] calls it unclean (*immunda*). Aelian[200] says that the χρέμης has a larger barbel than the γαλῆ, which has a larger barbel than the ἥπατος. Oppian[201] says that the χρέμης lives in the sea not far from rivers or lakes, where the water is somewhat less salty and considerable silt is in suspension. Aristotle [202] mentions the χρέμψ in the same passage as the χρόμις as a fish with sharp hearing. Mair[203] suspects that χρεμψ here is a mere variant reading for χρόμις and should be omitted, but it may well denote a different fish.

The χρόμις of Aristotle has been identified by Cuvier,[204] J. Müller,[205] Aubert-Wimmer,[206] Külb,[207] Schmid,[208] Brands,[209] and others as the maigre, *Sciaena aquila* Risso, generally called μυλοκόπι in Modern Greek,[210] but κρανιός at Chalcis and chro at Marseille.[211] Mair[212] is inclined to concur in this identification. Gossen identifies the χρόμις of Hesychius as the gurnard, *Trigla gurnardus* Linnaeus,[213] and with regard to Hesychius' equation of ὀνίσκος with χρέμυς, he says[214] that if the word is equivalent to χρόμις, it also denotes the gurnard, as in Oppian.[215] He similarly identifies[216] the χρόμυς of Aelian, on the ground that it could hear well[217] and grunted.[218] He refers[219] the κρέμυς that had an otolith in its head[220] to the related species *Trigla pini* Bloch. But he identifies the χρέμυς of Aelian[221] as the bearded ophidium, *Ophidium barbatum* Linnaeus, which is common throughout the Mediterranean and in the Adriatic, but has coarse flesh that is inferior as a food.[222] Thompson,[223] who regards these names as variants, says that they denote *Sciaena aquila* and sometimes *Umbrina cirrhosa*. Aelian's account of the χρέμης in particular, he says, suggests the latter species, which has so conspicuous a barbel, or knob, below its chin that fishermen at Bayonne and Arcachon call it verrue, or bourrugue or bourruget, a word meaning "wart."

Unless Heshchius' equation of ὀνίσκος with χρέμυς is an outright error, χρέμυς and its variants χρέμις, χρέμης, and χρέμψ must have been used, although infrequently, as terms for a type of cod or hake, possibly *Phycis* sp. and *Motella* sp., and should therefore be regarded as distinct in usage from χρόμις and its variants, even though these words may all be cognates. This hypothesis is rendered more plausible by the fact that Aelian associates the χρέμης closely with the γαλῆ and the ἥπατος and uses χρόμυς as a term for a distinctly different kind of fish.

19. Φυκίς

Another fish name that merits discussion in connection with the gadoids is φυκίς. Aristotle[224] states that oviparous fish as a rule spawn but once a year, but that the small φυκίδες are an exception, spawning twice a year, The male, moreover, differs from the female in being blacker and having larger scales. Elsewhere[225] he classifies the φυκίς among the fish that feed habitually on mud or seaweed or sea moss or the so-called stalk weed or growing plants and remarks that the only meat it will touch is that of prawns. In the light of his comment on the fish's diet, it is noteworthy that φυκίς is apparently a derivative of φῦκος, "seaweed," probably applied to the fish either because it fed on seaweed or because it was commonly found among seaweed.[226] Aristotle[227] in another passage says that the φυκίς, like the κόττυφος and the κίχλη (probably *Crenilabrus pavo* Cuvier and Valenciennes and *Coricus rostratus* Cuvier and Valenciennes), changes its color. Usually it is white, but in spring it is mottled; and it is the only fish that builds a nest for itself, the female laying her spawn in this bed or nest. In still another passage[228] he describes the φυκίς as being stickle-backed and having a speckled skin. Plutarch[229] and Ovid[230] also refer to this habit of building a nest. Pliny[231] translates the above passage of Aristotle almost verbatim and in another passage[232] classifies the phycis as a rockfish. Other authors also classify it as a rockfish,[233] and it is so defined in various lemmas.[234]

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[192] *Op. cit.* (see note 57): 184.
[193] *Op. cit.* (see note 59): 66–67.
[194] *Hist. an.* 534 a 8; cf. Plin. *N.H.* 10.193.
[195] *Ibid.* 535 b 16.
[196] *Ibid.* 543 a 2.
[197] *Ibid.* 601 b 29; cf. Plin. *N.H.* 9.57; Aelian. *Nat. an.* 9.7; Aristot. apud Athen. 7.305.d (p. 296 Rose).
[198] *N.H.* 32.153. Pliny also attributes nest-building to the chromis; but this is an error arising from hasty reading of Ovid. *Hal.* 121–122. On this point, cf. esp. E. de Saint-Denis, "Quelques bévues de Pline l'Ancien dans ses livres des poissons," Rev. Philol. **18**: 156–157. 1944.
[199] *Hal.* 121. [200] *Nat. an.* 15.11. [201] *Hal.* 1.112.
[202] *Hist. an.* 534 a 8.
[203] Note on Oppian. *loc. cit.*
[204] *Op. cit.* (see note 61) **5**: 41.
[205] Arch. Anat. 1857: 259.
[206] *Aristoteles Tierkunde* **1**: 144.
[207] *Aristoteles*, p. 603.
[208] "Die Fische in Ovids Halieuticon," Philologus, Supplementband **11**: 305. 1907–10.
[209] *Loc. cit.*
[210] Cf. Apostolidès, *op. cit.* (see note 185): 13.
[211] Cf. Cuvier, Ann. Inst. Archéol. 1842: 73.
[212] Cf. note on Oppian. *Hal.* 1.112.
[213] "Hesych." (see note 39), no. 2343.
[214] *Ibid.*, no. 2341.
[215] *Hal.* 1.112.
[216] "Aelian' (see note 32), par. 128.
[217] *Nat. an.* 9.7.
[218] *Id.* 10.11.
[219] "Athen." (see note 32), p. 256.
[220] Aristot. apud Athen. 7.305.d.
[221] *Nat. an.* 12.11.
[222] Cf. Day, *op. cit.* (see note 16) **1**: 326.
[223] *Op. cit.*: 291–292.

The reference to nest-building led Cuvier[235] to identify the φυκίς as the black goby, *Gobius niger* Linnaeus, an identification originally approved by Thompson,[236] who referred to Aristotle for support. According to Aubert-Wimmer,[237] Aristotle's allusion to stickles pointed to the stickleback, *Gasterosteus aculeatus* Linnaeus, and the 10-spined stickleback, *Gasterosteus pungitius* Linnaeus, which build nests, or to *Gobius niger*, the former being the more attractive identification. But Mair [238] says that it is now known that some at least of the wrasses build nests and that all the other evidence points to one of the wrasses. He calls attention to the fact that the scholiast on Oppian[239] equates φυκίδες with λαπίναι and concludes from the fact that *Crenilabrus pavo* is called λήπαινα in Modern Greek,[240] λαπίνα μαύρη and λαπίνα μεγάλη at Chalcis,[241] that it is likely that this is the φυκίς of the ancients. Thompson[242] subsequently identified the φύκης or φυκίς as a wrasse, perhaps especially *Labrus mixtus* Linnaeus, but confused at times with the gobies, which are also nest-builders.

Numerous variants of lapina and lapaina are found in Italy and Sicily, mostly denoting *Crenilabrus pavo* and allied species. These apparently go back to a Latin form labeo "big-lipped."[243] Italian fico, which probably goes back to the root of φυκίς, is discussed at considerable length by Barbier,[244] who says that in the Italian-English dictionary of Florio (1688) phici, phiscide, fici, fico are defined as follows: "a fish that is sometimes white and sometimes thick with black spots, and frames itself a nest in the grass or reeds by the sea-side, and there deposits its spawn and sits on the young, known in Rome as *fico*." Barbier assumes from the definition that this is the phycis of Rondelet,[245] who described the fish in very similar terms and says that it was called mole by the French, phyco by the Italians, molere by the Spaniards, and sometimes pittara at Naples. This fish is *Phycis mediterraneus* De la Roche, and Barbier found this identification of the φυκίς of the ancients more acceptable than the one made by

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[224] *Hist. an.* 567 b 18.

[225] *Ib.* 591 b 10.

[226] Cf. Brands, *op. cit.* (see note 57): 182. Strömberg (*op. cit.* [see note 59]: 83) suggests the following factors: (1) The fish fed on seaweed; (2) it changed color with the seasons like certain types of seaweed; and (3) it built a nest in the midst of algæ and seaweed.

[227] *Hist. an.* 607 b 18; cf. Aelian. *Nat. an.* 12.28; Plin. *N.H.* 9.81.

[228] Apud Athen. 7.319.c.

[229] *Mor.* 981.f (*De sollertia animalium* 33).

[230] *Hal.* 122.

[231] *N.H.* 9.81.

[232] *Id.* 32.150.

[233] Cf. Ps.-Hippocr. *De diaet.* 2.48; Galen. *Alim. fac.* 3.27,29 (pp. 367.1 and 368.3 Helmreich); *Vict. att.* 8.59 (p. 442.16 Helmreich); Oribas. *Coll. med.* 3.2.10; Diocles apud Athen. 7.305.b; Numen. *ib.* 7.319.b; Oppian. *Hal.* 1.126.

[234] Cf. Papendick, *op. cit.* (see note 31): 4, 7.

[235] *Op. cit.* (see note 61) **4**: 151; **12**: 7.

[236] Note on Aristot. *Hist. an.* 567 b 20.

[237] *Op. cit.* (see note 206) **1**: 142.

[238] Introd. to his ed. of Oppian: li–liii.

[239] *Hal.* 1.126.

[240] Cf. Th. von Heldreich, *La faune de la Grèce* (Athens, 1878).

[241] Cf. Apostolidès, *op. cit.* (see note 185): 26.

[242] *Glossary*, p. 276.

[243] Cf. Cl. Merlo, "Note etimologiche e lessicali," Atti Accad. Sci. Torino **42**: 19. 1906–1907. H. Schuchardt, Zeitschr. roman. Philol. **31**: 641–646. 1907.

[244] *Op. cit.* (see note 104): 34–37; cf. also Meyer-Lübke, *op. cit.* (see note 19): 534.

[245] *Libri de piscibus marinis* 6 (x): 186–188. Lugduni, 1554.

Cuvier. More recently Gossen[246] has advanced the same identification.

Barbier comments on the possibility that names from the root of φυκίς were applied to various fishes, in view of the variants φυκίς, φύκην, and φύκης. Rondelet[247] believed that the φυκίς and the φύκην were different fishes. Brands,[248] recognizing only two variants, φυκίς and φύκης, the former feminine and the latter masculine, says that while the former may have denoted the female and the latter the male of the same species, it is more probable that the two denoted different fishes. Barbier cites from Carus[249] as examples of fish names from the root of φυκίς the following: (1) fico at Rome, fica at Naples, and figo at Venice for *Phycis mediterraneus* De la Roche; (2) baca ficu and pesce ficu in Sicily, figora at Rome, fica at Naples, pesce fica at Palermo, and pisci ficu at Messina for *Gadus minutus* Linnaeus; (3) Italian fico for *Gadus luscus* Lacépède; and (4) Italian pesce fico "codfish" (Florio) and figaotto at Genoa for *Gadiculus blennioides* Günther. He goes on to say that the root of φυκίς has also been the source of names for other fishes than gadoids and their close relatives, but that these names always refer to fishes which frequent seaweed or feed on it. *Sciaena aquila* Risso, for example, bears such names as figoun and figou in the Provence (figon at Nice), fagao at Genoa (fegaro, according to Bonaparte; figau, according to Sassi), figao on Elba, fico at Tunis, and French fégaro at Damiette. Schuchardt[250] givea figa and figo as names for *Stromateus fiatola* Linnaeus at Adria (also called figa at Venice and figo at Trieste, according to Carus) and figa at Spalato for *Labrus bimaculatus* Linnaeus (*Labrus mixtus* Linnaeus). He explains these names as an allusion to the color of the fish, and Barbier, assuming that he derives them from Latin *ficus, fica* "fig," characterizes the application as farfetched, in view of the coloration of *Stromateus fiatola*, which in no respect resembles that of a fig. He believes that these names also go back to the root of φυκίς. Modern Greek φυκόψαρο is a generic term for any species of wrasse.[251]

One factor of importance which has been given almost no consideration is that φυκίς is in no ascertainable instance equated with a name identifiable as one of the gadoids, and it has already been noted that one of the primary difficulties met in idenifying names applied to gadoids is a marked tendency to make these names mutually synonymous. As a result, it is generally easy to recognize that a given name belongs in the gadoid group, but often impossible to assign it with certainty to any particular species. It seems almost certain that the φυκίς was a type of nest-building wrasse, and Mair's identification is probably correct. At the same time, it is possible that a Latin name from the root of φυκίς, unrecorded in the extant literature, was applied not only to certain types of wrasse, but also to certain gadoids, in both cases because the fishes were closely associated with seaweed.

20. Λελεπρίς

For the reasons given above, the λελεπρίς defined by Hesychius as a name for the φυκίς and mentioned by Pliny [252] in connection with the *phycis*, identified by Gossen[253] as perhaps *Phycis mediterraneus* De la Roche, should be referred to the wrasses.

21. Βρύττος

Hesychius defines βρύττος as a kind of pelagic echinoderm, also the name of a fish. The echinoderm, mentioned by Aristotle,[254] is probably *Brissus unicolor* Klein. Gossen[255] identifies the fish as perhaps *Physiculus dalwicki* Kaup, a small gadoid which resembles a sea-urchin. Thompson[256] does not venture an identification.

22. Asellus

Latin asellus, "assfish," is approximately equivalent to and perhaps a translation of Greek ὀνίσκος. It is often equated with ὀνίσκος in lemmas,[257] as it is in Cassius Felix.[258] Pliny,[259] moreover, uses asellus to translate Aristotle's ὄνος. Asellus, ὄνος, and ὀνίσκος all mean "assfish," asellus and ὀνίσκος being diminutive formations; and asellus, like the Greek names, refers to the color of the fish.[260] Pliny speaks of two kinds of asellus, the collyrus (or callarias) and the bacchus, of which the bacchus, a larger type, was preferred because it was caught only in the deep sea.

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[246] "Hesych." (see note 39), no. 507; "Aelian" (see note 32), par. 140; "Athen." (see note 32): 262.

[247] *Loc. cit.*

[248] *Op. cit.* (see note 57): 182.

[249] *Op. cit.* (see note 5) **2**: 573.

[250] *Op. cit.* (see note 243): 645; cf. also 28 (1904): 443.

[251] Cf. Apostolidès, *op. cit.* (see note 185): 25; Hoffman-Jordan, *op. cit.* (see note 28): 269, 270.

[252] *N.H.* 32.149.

[253] "Hesych." (see note 39), no. 1266.

[254] *Hist. an.* 530 b 4.

[255] "Hesych." (see note 39), no. 328.

[256] *Glossary*: 36.

[257] E.g., *Hermen. Amplon.* 89.2,37; *Hermen Leid.* 16.54; *Hermen. Vat.* 436.34; *Hermen. Monac* 187.2.

[258] 28 (p. 44.17 Rose).

[259] *N.H.* 9.61; 32.145.

Barbier[261] identifies the asellus of Pliny as the common hake, *Merluccius vulgaris* Fleming, an identification which receives some support from the Romance nomenclature. Rondelet[262] reports that in his day this species was called asello and nasello in Liguria, and Faujas and Sassi report nasello as current at Genoa.[263] Today this species is called asinel at Fiume, naselli at Genoa, and nasello at Ancona.[264] In addition, Barbier cites Rolland as giving nasello as current on Elba and Malaspina as giving nasell as current at Parma. He also calls attention to French anon and anon de mer as names for the eglefin, *Gadus aeglefinus* Linnaeus. Italian nasello is reported as a name for *Merlucius cyprinus* by Meyer-Lübke,[265] although there is no confirmation from other sources. Badham[266] believed that the asellus was the sea-tench, *Phycis mediterraneus* De la Roche, better known as the Mediterranean hake. On the basis of the Romance nomenclature, the asellus is more plausibly referred to the common hake. Since Pliny indicates that the name was applied to at least two types, one of these would be the common hake and the other possibly the Mediterranean hake or the fork-beard hake, *Phycis blennioides* Bloch and Schneider.

23. ASINUS

The fish name asinus appears in Polemius Silvius[267] in the form asinis. As asellus is equivalent to *ὀνίσκος*, so asinus is equivalent to *ὄνος*. This name is almost certainly, like the others, an allusion to the ass-gray color of the fish.[268] The evidence is insufficient to permit a specific identification, but it may be noted that Rondelet[269] reported asino as a current Italian name for the common hake, *Merluccius vulgaris*, and Thompson[270] cites asinel at Fiume for this species.

The conclusions reached relative to the meanings of the ancient names may be summarized as follows:

GREEK NAMES

1. *Βάκχος* (sect. 15): Apparently a name for one of the gadoids, as well as a type of scienid and a type of gray mullet.
2. *Βρύττος* (sect. 21): Possibly the small gadoid *Physiculus dalwicki* Kaup, although this is very uncertain.
3. *Γάδος* (sect. 17): One of the gadoids, similar to the *ὄνος* and the *ὀνίσκος*.
4. *Γαλῆ* (sect. 2): When the habitat is the sea, it may denote *Phycis* sp. and *Motella* sp. When it refers to a freshwater fish, it probably denotes principally the burbot, *Lota vulgaris* Cuvier, but also probably sometimes the lamper-eel, *Petromyzon fluviatilis* Linnaeus.
5. *Δελκανός* (sect. 5): Probably the burbot, *Lota vulgaris* Cuvier.
6. *Ἥπατος* (sect. 3): One of the larger marine gadoids, possibly a type of ling.
7. *Καλλαρίας* (sect. 11): Probably one of the smaller marine gadoids.
8. *Λαζίνης* (sect. 12): Possibly one of the gadoids.
9. *Λεβίας* (sect. 4): When the habitat is the sea, it denotes one of the marine gadoids. As a lake fish, it is probably the burbot, *Lota vulgaris* Cuvier. As a Nile fish, it is probably *Labeo niloticus* Cuvier.
10. *Λελεπρίς* (sect. 20): A type of wrasse.
11. *Μάξεινος* (sect. 16): One of the gadoids.
12. *Ὀνίας* (sect. 10): A descriptive term, not a fish name.
13. *Ὀνίσκος* (sect. 9): Probably denotes the common hake, *Merluccius vulgaris* Cuvier.
14. *Ὄνος* (sect. 8): Probably denotes the Mediterranean hake, *Phycis mediterraneus* De la Roche, and the fork-beard hake, *Phycis blennioides* Bloch and Schneider.
15. *Ὄξος* (sect. 13): Probably a ms. error for *ὄνος*.
16. *Πρέπων* (sect. 6): Probably one of the larger marine gadoids.
17. *Πρόβατον* (sect. 7): Probably one of the larger marine gadoids.
18. *Φυκίς* (sect. 19): A type of wrasse, probably *Crenilabrus pavo* Cuvier and Valenciennes.
19. *Χρέμης* (sect. 18): Possibly denotes *Phycis* sp. and *Motella* sp.

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[260] Cf. Varro *Ling*. 5.77 and note of R. G. Kent *ad loc.*

[261] *Op. cit.* (see note 104): 26.

[262] *Op. cit.* (see note 245) **9** (ix): 272–276.

[263] Cf. Carus, *op. cit.* (see note 5) **2**: 573.

[264] Cf. *La pesca nei mari* (see note 4) **3**: 95, 60, 31.

[265] *Op. cit.* (see note 19): 56.

[266] *Op. cit.* (see note 98): 350–353.

[267] *Chron. min.* I, 544, 6. Cf. H. Schuchardt, "Zu den Fischnamen des Polemius Silvius," Zeitschr. roman. Philol. **30**: 719. 1906. Thompson (*Glossary*, p. 183), unjustifiably, it appears, suspects an error in copying Plin. *N.H.* 9.61.

[268] Cf. Barbier, "Noms de poissons," Rev. Langues Romanes **54**: 151. 1911.

[269] *Loc. cit.* (see note 261).

[270] *Glossary*: 97.

LATIN NAMES

1. Asellus (sect. 22): Probably principally the common hake, *Merluccius vulgaris* Cuvier, possibly also the Mediterranean hake, *Phycis mediterraneus* De la Roche, or the fork-beard hake, *Phycis blennioides* Bloch and Schneider.
2. Asinus (sect. 23): Possibly the common hake, *Merluccius vulgaris* Cuvier.
3. Galaxias (sect. 14): Possibly a synonym of mustella, used more particularly as a term for *Phycis* sp. and *Motella* sp.
4. Mustela (sect. 1): When the habitat is the sea, it probably denotes *Phycis* sp. and *Motella* sp. When it refers to a freshwater fish, it denotes principally the burbot, but probably also sometimes the lamper-eel, *Petromyzon fluviatilis* Linnaeus.

The major applications of ancient names to various species of gadoids were as follows:

1. *Phycis mediterraneus* De la Roche and *Phycis blennioides* Bloch and Schneider: Usually called mustela in Latin, perhaps also asellus and galaxias. Usually called ὄνος in Greek, perhaps also γαλῆ and χρέμης.
2. *Merluccius vulgaris* Cuvier: Usually called ὀνίσκος in Greek and asellus in Latin, perhaps also asinus.
3. *Motella tricirrata* Nilsson: Usually called mustela in Latin, perhaps also galaxias. Perhaps known as γαλῆ and χρέμης in Greek. *Motella mustela* Nilsson: Usually called mustela in Latin, perhaps also galaxias.
4. *Lota vulgaris* Cuvier: Known as mustela in Latin and as γαλῆ, λεβίας, and δελκανός in Greek.
5. *Molva elongata* Risso: Perhaps known in Greek as ἥπατος.

There is little evidence that codfishes were much esteemed as food fish by the Greeks. Archestratus[271] says that ὄνοι of respectable size were caught at Anthedon, but that he personally found the flesh rather spongy and unpalatable, although others praised it highly. Anaxandrides[272] mentions ὄνοι as a banquet item; Diphilus[273] says that the λεβίας was popular among the Rhodians; and Archestratus[274] speaks of buying both the λεβίας and the ἥπατος at Delos and Tenos.

When we turn to the Romans, we find a different picture. Ennius[275] considered the marine mustela superior to all other fishes when caught at Clipea, and Pliny[276] ranked it second only to the parrotfish in his time, although it was esteemed chiefly for its liver. The mustela of the Lake of Constance, which must be the burbot, in his opinion compared favorably in excellence of taste with the marine mustela. As for the asellus, Pliny[277] says that in former times the asellus and the sea-bass ranked second only to the sturgeon. It was still in high favor not long before his time, for in the reign of Nero there was a saying, *post asellum diaria non sumo* ("After an asellus I don't take ordinary fare").[278] Ovid,[279] moreover, considered the asellus quite unworthy of such an ugly name. According to Varro,[280] the best specimens were caught off Pessinus in Galatia. In view of the obvious esteem in which the asellus was held, it is somewhat surprising to find that the only use made of it in the cookbook of Apicius is in grated form as an ingredient in an elaborate milk dish.[281] Possibly this is a reflection of Greek taste.

The ancient physicians were inclined to regard codfishes with favor from the dietetic point of view. Galen considered the ὄνος and the ὀνίσκος tender and relatively easy to digest,[282] although he deemed ὀνίσκοι taken off river mouths somewhat inferior and more difficult to digest.[283] Xenocrates[284] says that the flesh of the ὀνίσκος is difficult to assimilate, but easy to pass, and nourishing. In another passage,[285] he approves the flesh of the ἥπατος and the μαζέας as being of good taste, although hard to digest, but nourishing and easily passed. Oribasius[286] recommends the ἥπατος as providing a nourishment that is excellent for feeble persons and invalids. Euthydemus[287] remarks that the δελκανός is very wholesome when pickled in brine.

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[271] Apud Athen. 7.315.f (frg. 35 Ribbeck, frg. 14 Brandt).

[272] *Ib.* 4.131.e (in Kock, *Comicorum Atticorum fragmenta* **2**: 151).

[273] *Ib.* 4.132.d.

[274] *Ib.* 7.301.d (frg. 30 Ribbeck, frg. 27 Brandt).

[275] *Heduph.* 1 (apud Apul. *Apol.* 39).

[276] *N.H.* 9.63.

[277] *Id.* 9.61.

[278] Petron. 24.7.

[279] *Hal.* 133.

[280] *Men.* 403 (apud Gell. 6.16.5).

[281] 4.133.

[282] *Alim. fac.* 3.29,40 (pp. 368, 384 Helmreich).

[283] *Alim. fac.* 3.29 (p. 368.21 Helmreich).

[284] *Alim. aquat.* 14.

[285] *Id.* 10 (exc. Oribas. *Coll. med.* 2.58.27).

[286] *Coll. med.* 3.15.7.

[287] Apud Athen. 3.118.b.

ARCHEOLOGY.—*A Veraguas grave*.[1] Karl P. Curtis, Gamboa, C. Z., and Gordon R. Willey, Bureau of American Ethnology.

The archeological culture area of Veraguas has been defined as that part of the modern Panamanian province of the same name which lies on the Pacific side of the continental divide. As such it embraces the coast from the Río Tabasara to the southwestern extremity of the Azuero Peninsula. Inland the extent of the Veraguas culture is as much as 50 miles in some places; however, distributions are not well known. The distinctiveness of Veraguas as a culture area is well emphasized by the two archeological regions which flank it. On the east is the better-known Coclé area and to the west the Chiriquí. The Veraguas ceramic, metallurgical, stone, and grave-type styles differ markedly from those of these neighboring areas. The time-depth of the Veraguas culture is an unknown quantity as is that of Coclé or Chiriquí, but it is believed that all three of these major complexes of Pacific Panama belong to the late periods, that is, the two or three centuries prior to Spanish discovery in the early sixteenth century.

As data on Veraguas are so few,[2] it is the purpose of this little paper to place on record a grave of this culture type and its contents. The scientific significance of the grave lies solely in the fact that it is an associational unit.

The grave in question was excavated by the senior author during the last week in January 1948. Notes pertaining to the excavations and the collection were studied by the junior author in April of the same year. The collection is now in the possession of the National Museum of Panama, R. P.

The site at which the excavation was made lies about 23 miles northwest of the city of Soná in what is probably the heart of the Veraguas culture area. Espala is the nearest community. This is hilly upland country, and the site, which is a cemetery, is on the top of a hill about a mile distant from the house of Juan Perez, the owner of the property. By early 1948 some 50 or 60 shaft graves in the cemetery had been looted by treasure-hunters. The particular grave opened by the senior author was first detected by surface indications in the form of a crude circle of stones, each partially imbedded in the soil. This circle measured 9 feet in diameter and showed a slight central depression where the fill of the grave had settled. The tubular grave shaft also proved to be about 9 feet in diameter from top to bottom, a depth of 14 feet. The shaft was filled with tightly packed clay rubble mixed with small stones and charcoal. The grave chamber at the terminus of the shaft was simply an enlargement of the former. It was floored with clay and flat stones.

No human skeletal material was found in the chamber, but seven pottery vessels, four stone celts, nine chipped stone projectile points, and some minor miscellaneous items were recovered. These materials are described below. They are listed by the temporary catalogue numbers assigned to them at the time of study.

POTTERY

The ware qualities of all seven vessels are virtually identical. The paste is uniformly sandy and, in addition, is tempered with occasional particles of large grit and crushed white rock. It is fairly homogeneous but friable and crumbly. The vessels are fired to a buff or reddish buff throughout, although there are occasional black fire-cloudings spotted on the surface. Most of the vessels seem to have been buff-slipped, and the exterior surfaces are usually well smoothed or even polished. Vessel walls average 7–8 mm. in thickness. All decoration is achieved by plastic techniques.

$\frac{1}{\text{C-48}}$. A subglobular bowl on a high pedestal base (Fig. 1, *a*). Vessel body has a sharp shoulder angle, and on this angle there is an encircling flange which extends upward and outward forming a "gutter." This flange is terminated on opposite sides of the vessel to allow for the placement of adorno figures. The total diameter of the vessel, including the shoulder flange, is 30 cm. The pedestal base is wide and high, although it has been broken and partially restored.

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[1] Received October 27, 1948.

[2] See S. K. Lothrop, *The archeology of Panama*, Handbook of South American Indians (Bur. Amer. Ethnol. Bull. 143) **4**: 144, 159–160, 1948. Dr. Lothrop now has in press (Mem. Peabody Mus. Arch. and Ethnol., Harvard University) a major work on Veraguas. Aside from Lothrop's studies there are no published accounts of Veraguas archeology.

Decoration is by relief modeling and punctation. The edge of the shoulder flange is marked with a double row of round-dot punctations plus crimping or scalloping. The adornos are modeled frog figures. One is partially destroyed, but the other shows a large, flat-topped head, large ears, round button-punctated eyes with appliqué brow ridges, rachitic arms, huge hands, and male (?) genitalia. These frog adorno figures are hollow, and on the inside of the vessel small holes open through into the interior chambers of the adornos. On the other diameter of the vessel, on opposite sides, are lizards or alligators executed in relief appliqué. These animals face in opposite directions. They have long legs, big hands, large heads, and a serrated back and tail. Features such as eyes, mouth, and hands are delineated by punctations as well as appliqué strips.

$\frac{2}{\text{C-48}}$. A subglobular bowl on a pedestal base (Fig. 1, *b*). The diameter of this bowl is 18 cm. The rim is unmodified; the base is of medium height and is markedly outflared. There are adorno zoomorphic faces on two sides of the bowl located just above the median line. These are done in appliqué strips and punctations. The nose of the face is also a small loop handle. Incised buttons and incisions suggest eyes and mouth. Wings or arms are indicated by arching loops.

$\frac{3}{\text{C-48}}$. A subglobular bowl on a flaring pedestal base (Fig. 1, *c*). Unmodified rim. Maximum diameter is 15.8 cm. There is appliqué decoration on two sides of the bowl. The figure is possibly that of an alligator. Features of punctated pellet eyes and indented arched loops are much like those described for other vessels.

$\frac{4}{\text{C-48}}$. A subglobular bowl with tripodal support (Fig. 1, *d*). Maximum diameter is 13 cm. Legs are 2.5 cm. high. Rim is unmodified. There are two projecting animal heads or adornos on opposite sides of the bowl, and there are punctated arched loops on either side of each head. A small hole has been punched through the vessel wall just above each head. On the other two sides of the vessel are faces indicated by arched and connected brows. These brows join to form a snout or mouth. Eyes below the brows are punched pellets. Vessel legs are slablike with rounded ends. These legs are also effigy forms, inverted, depicting either humans or birds.

$\frac{5}{\text{C-48}}$. Small bowl on tripodal base (Fig. 1, *e*). Maximum diameter is 5.5 cm. Bowl has low shoulder angle and slightly everted rim. Feet supports are V-shaped slabs. No decoration.

$\frac{6}{\text{C-48}}$. Globular miniature vessel on tripod base (Fig. 1, *f*). Two vertical strap handles below rim. Rim is outflared. Feet are round nubbins. Maximum diameter is about 4 cm.

$\frac{23}{\text{C-48}}$. Open bowl on pedestal base (Fig. 1, *g*). This vessel shows the poorest shaping and smoothing of any in the grave lot. Maximum diameter is 7.8 cm. Rim is unmodified. On opposite sides of the vessel, just below the rim, are large nodes. Each is punched as though to represent two eyes. Each is also flanked, on both sides, by two smaller pellet nodes which are plain.

STONEWORK

The four celts $\left(\frac{7\text{–}10}{\text{C-48}}\right)$ are all made of a gray stone with white inclusions. All have a pointed poll, are diamond-shaped in cross section, and are well formed. Three of them are well polished. One shows a marked flare of the bit end (Fig. 1, *h*). They vary in length from 24 to 12 cm, in width from 6.7 to 4.5 cm, and in thickness from 3.8 to 2 cm.

The stone projectiles are all rather crudely chipped, show only heavy retouch, and are all planoconvex in form.

$\frac{11}{\text{C-48}}$. A large projectile of red stone, resembling argillite (Fig. 1, *n*). The blade is ovate-triangular, there is very little shoulder angle, and a stem is only suggested. Length 8.5 cm.

$\frac{12}{\text{C-48}}$. A large projectile of yellow-brown chert (Fig. 1, *o*). One shoulder is quite distinct; the other is only slightly indicated. Blade is ovate-triangular. Stem is tapered. Length 10.5 cm.

$\frac{13\text{–}17 \text{ and } 19}{\text{C-48}}$. Small projectiles (Fig. 1, *i–l*). Triangular or ovate-triangular blades. Shoulder angles and differentiation of stem and blade tends to be vague. Made of yellow-brown chert, grey chert, or reddish argillite (?). Length 5.1 to 3.2 cm.

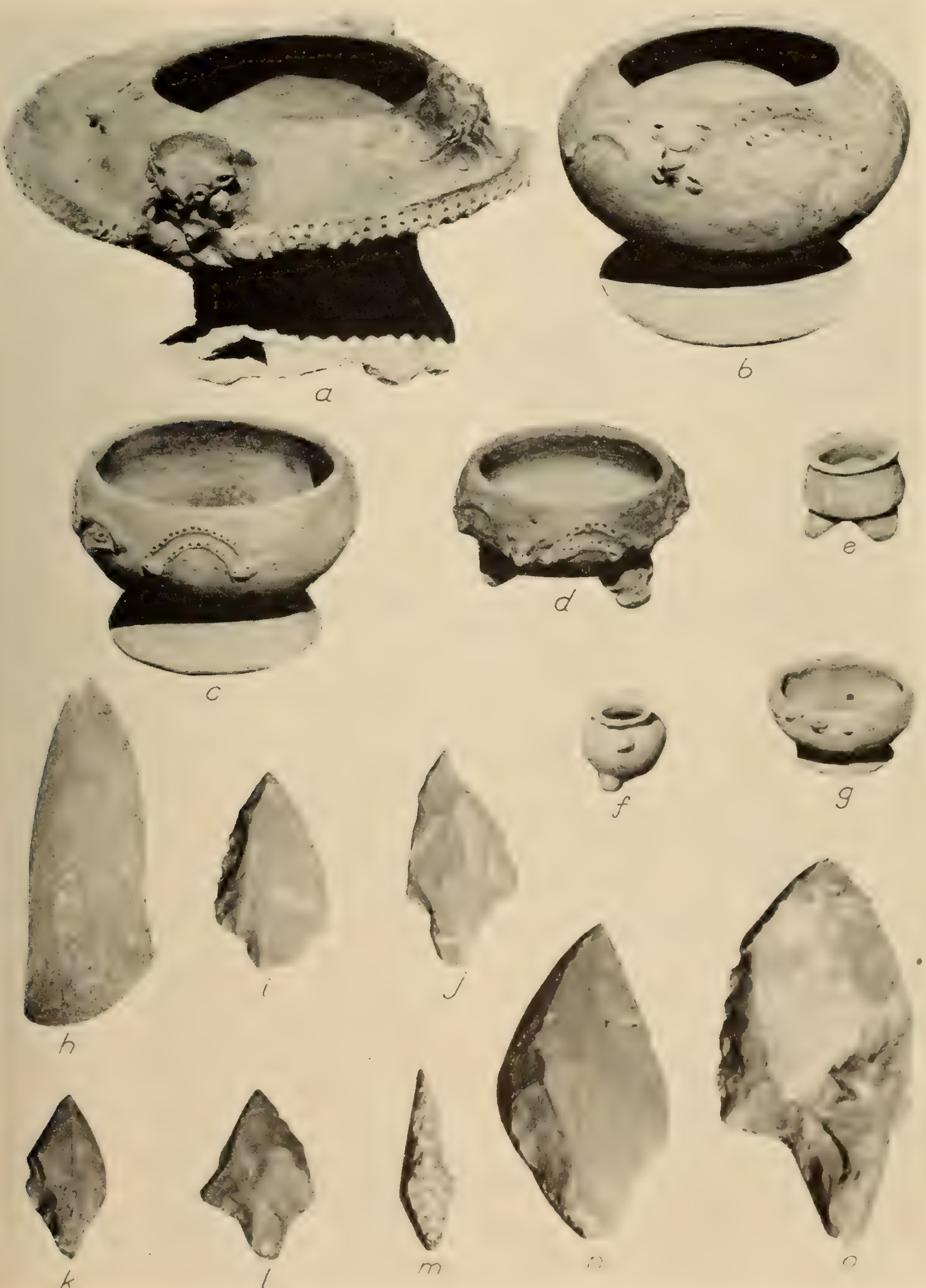

Fig. 1.—Veraguas pottery and stonework from Juan Perez site.

$\frac{18}{C\text{-}48}$. A long, core point, also planoconvex (Fig. 1, *m*). As thick as it is broad. Tapered stem. Yellow-brown chert. Length 4.9 cm.

MISCELLANEOUS

Besides the artifacts described, a small lump of amber $\left(\frac{20}{C\text{-}48}\right)$, a smoothing pebble of heavy ore $\left(\frac{21}{C\text{-}48}\right)$, and five small quartz crystals $\left(\frac{22}{C\text{-}48}\right)$ were also taken from the grave chamber.

COMMENT

The similarity of this single grave and its contents to the type picture of Veraguas, as it is drawn by Lothrop (*ibid.*, pp. 159–160), is striking. First, Lothrop states that Veraguas graves and cemeteries are usually located upon hills or mountain ridges, as is the case with the Juan Perez site; second, the grave shaft and chamber of the grave discussed here check very closely with that author's observations; third, the stone celts and chipped blades or points seem to be identical with classic Veraguas types; and fourth, Veraguas pottery forms and decorations are clearly duplicated in the seven vessels which we have described. The assemblage is an indubitable Veraguas unit.

ENTOMOLOGY.—*The mosquitoes of Ponape Island, eastern Carolines.*[1] KENNETH L. KNIGHT[2] and HERBERT S. HURLBUT,[3] Naval Medical Research Institute, Bethesda, Md.

This paper is based upon a collection of mosquitoes (Diptera-Culicidae) made by the junior author on Ponape Island early in 1948. Six species are treated, of which three are described as being new. Bohart and Ingram (1946), in a comprehensive treatment of the mosquitoes of the Caroline Islands, record 14 species as occurring in the whole island group. The three new species here described bring the total number known for the Carolines up to 17, of which 12 appear to be endemic. Farner (1944a and 1944b), in a review of the literature relating to the mosquitoes of the Caroline Islands, lists only three species for the island of Ponape: *Culex quinquefasciatus* Say, *Aedes aegypti* (Linnaeus), and an unidentified small dark mosquito species from Japuteick Island in Ponape harbor.

All holotypes are to be deposited in the U. S. National Museum; and the paratypes in the U. S. National Museum, the British Museum (Natural History), the Bishop Museum, Honolulu, and the California Academy of Sciences.

The help of John I. Thomas, HMC, U. S. Navy, in making this collection is gratefully acknowledged.

DESCRIPTION OF THE ISLAND

The island of Ponape is located in the eastern Carolines (lat. 6° 55′ N., long. 158° 15′ E). It has an area of approximately 145 square miles and is roughly circular in outline, with a diameter of about 13 miles. A coral reef surrounds the island, with an intervening shallow lagoon. The island is completely fringed by mangrove swamps which vary in width from a few yards to a mile. There is little or no coastal plain. A foothill belt of about 1 mile in width rises almost directly from the water's edge. There are extensive coconut groves in this zone, and cleared areas are found in the broader valleys on the north, west, and east. The remainder of the interior is mountainous and heavily wooded, with numerous peaks above 2,000 feet and a maximum elevation of 2,595 feet.

The annual rainfall is extremely heavy, probably averaging between 255 and 300 inches at Colonia on the north coast. There are about 300 rainy days per year. The wettest months are April through September, and the driest in January and February, which average about 10 inches each. The mean annual temperature is 83° F. There is little seasonal variation. The winds are south to southeast in August to October and northeast the rest of the year.

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[1] Received September 27, 1948.
[2] Lieutenant Commander, MSC, U. S. Navy.
[3] Commander, MSC, U. S. Navy.

The strongest winds occur from December to March.

The island is divided into five civil districts: Not, U, Matalanim, Kiti, and Sokas, in a pielike arrangement proceeding around the coast in a clockwise direction. The largest settlement is at Colonia on the north side, where the Civil Administration Unit is located. Other small settlements are located at Matalanim on the east coast and at Ronkiti and Wani Kiti on the west. The interior is uninhabited. The localities indicated on the sketch map (Fig. 1) are not villages in the usual sense but groups of widely separated dwellings scattered over areas of a square mile or more. The native population is Micronesian and totals about 5,000. There is little agriculture except for small patches of yams, taro, sugarcane, and bananas. Most of the coast is accessible only by trails and by boat. About ten miles of motor road exist on the north side. The interior has no roads and only a few trails.

KEY TO THE ADULTS

1. Tarsi dark....................................2
   Tarsi with definite pale markings............4
2. Pleuron prominently marked by 2 longitudinal broad dark integumental bands, the ventral one terminating medially on sternopleuron; no pleural scale patches....................
   ..*Culex (Culiciomyia) pullus maplei*, n. subsp.
   Pleuron not marked by dark integumental bands; 3 or more pleural scale patches present................................. 3

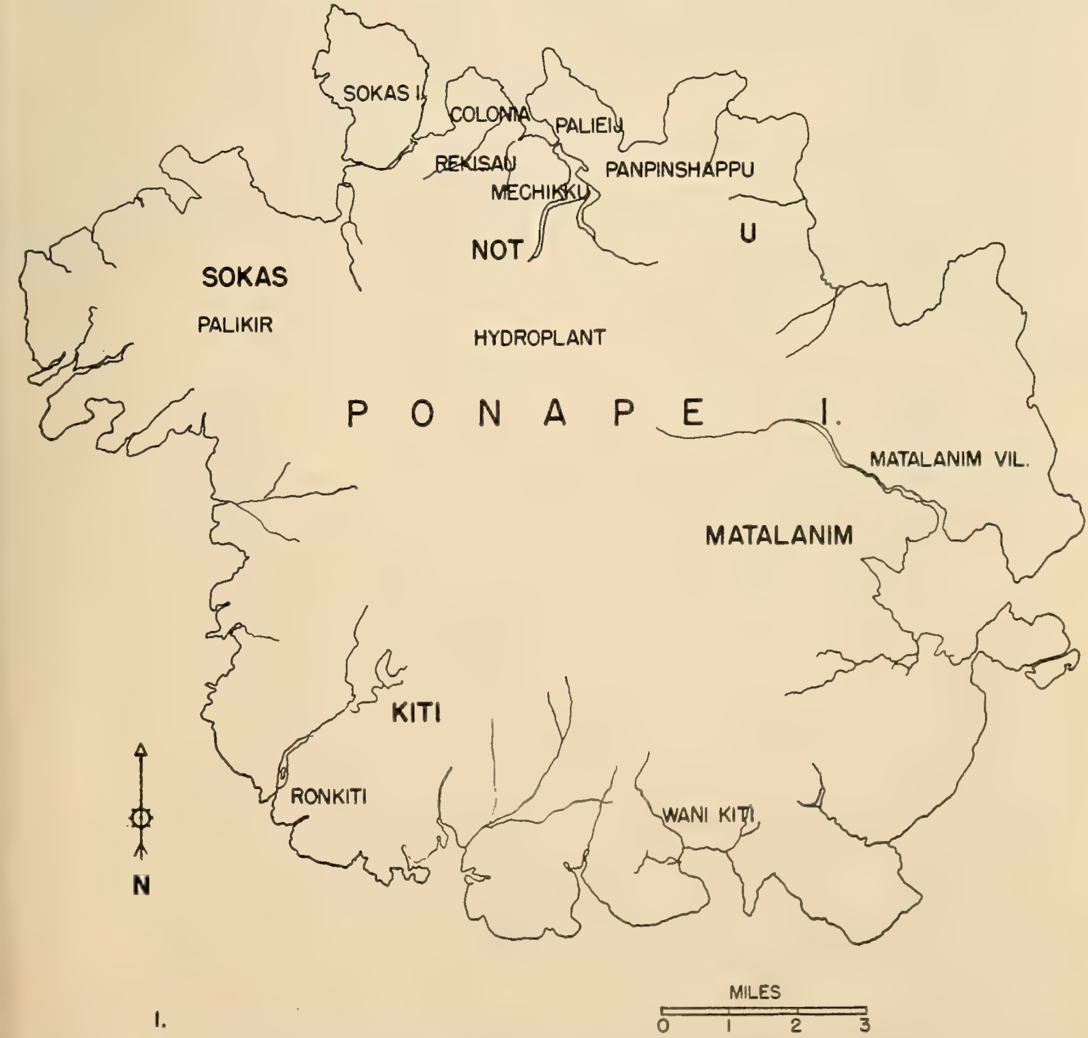


FIG. 1.—Map of Ponape Island. Specific localities labeled are those where collections were made.

3. Scutellum with narrow black scales (usually a variable number of narrow yellow scales present basally); postspiracular bristles present; scutum clothed with sparse hairlike black scales and marked with several rather indefinite patches of yellow scales.........
..*Aedes* (*Aedimorphus*) *senyavinensis*, n. sp.
Scutellum with narrow pale yellowish scales; no postspiracular bristles; scutum clothed with narrow brownish-yellow to brownish scales..*Culex* (*Culex*) *quinquefasciatus* Say
4. Proboscis banded; dorsal vertex scales narrow ....*Culex* (*Culex*) *annulirostris* Skuse
Proboscis dark; dorsal vertex scales nearly all broad.............................5
5. Fifth hind tarsal segment all white; scutum with a pair of thin admedian longitudinal pale lines and a rather broad crescent-shaped area of broad silvery scales on lateral margin over *ppn*..........................
...*Aedes* (*Stegomyia*) *aegypti* (Linnaeus)
Fifth hind tarsal segment with at least apical half dark; scutum with a complete median longitudinal pale band that tapers posteriorly to prescutellar area and there forks to posterior scutal margin..........................
....*Aedes* (*Stegomyia*) *hakanssoni*, n. sp.

KEY TO THE PUPAE

1. Only 1 terminal hair present on each paddle (*Aedes*).............................2
Two terminal hairs present on each paddle, one dorsal and the other ventral (*Culex*).......4
2. Paddles with a prominent marginal fringe of long hairs (Fig. 11).....*hakanssoni*, n. sp.
Paddles not possessing a marginal fringe of hairs....................................3
3. Hair 8 on abdominal segments II–VI prominent and distinctly spinelike in form; posterior half of paddle margin distinctly denticulate (Fig. 14)................*aegypti* (Linnaeus)
Hair 8 on abdominal segments II–VI very small and not spinelike; posterior half of paddle margin smooth and rather indistinct (Fig. 15) ....*senyavinensis*, n. sp.
4. Hair 5 on abdominal segments IV–VI double (rarely single) (dorsal paddle hair approximately twice length of ventral hair)........
......................*quinquefasciatus* Say
Hair 5 on one or more of segments IV–VI with more than 2 branches.................... 5
5. Hair 5 on abdominal segments V and VI with 2 or 3 branches; metathorax largely, or entirely, brown...........*annulirostris* Skuse
Hair 5 on abdominal segments V and VI nearly always with 5 or 6 branches; lateral half, or more, of the metathorax unpigmented (clear).............*pullus maplei*, n. subsp.

KEY TO THE LARVAE

1. Siphon with 1 pair of hair tufts (*Aedes*)......2
Siphon with 3 or more pairs of hair tufts (*Culex*)................................4
2. Comb teeth scalelike and arranged in a patch (Fig. 19)................*senyavinensis*, n. sp.
Comb teeth spinelike and arranged in a single line (Fig. 20)..............................3
3. Meso- and metathoracic pleural hair tufts each with a prominent basal spine; comb teeth with prominent lateral denticles (Fig. 20)...
.......................*aegypti* (*Linnaeus*)
Meso- and metathoracic pleural hair tufts not bearing a prominent basal spine; comb teeth with only a very fine basolateral fringe (Fig. 21)................*hakanssoni*, n. sp.
4. Siphon with six pairs of hair tufts (Fig. 24)...
........................*annulirostris* Skuse
Siphon with not more than four pairs of hair tufts..................................5
5. Siphon with 3 pairs of hair tufts, all in a line; siphon tapered from base (Fig. 23).........
....................*pullus maplei*, n. subsp.
Siphon with 4 pairs of hair tufts, third pair dorsally out of line to others; siphon tapered from about basal two-fifths (Fig. 22).......
.....................*quinquefasciatus* Say

Aedes (Stegomyia) aegypti (Linnaeus)

Figs. 2, 14, 20

A medium-sized brown, or black, and white species; with a dark proboscis, all hind tarsal segments basally banded (V all white), vertex scales nearly all broad, numerous white pleural scale patches (not forming definite bands), and pale dorsobasal bands and separate lateral white spots on the tergites. The scutum is distinctively marked as follows: Two thin admedian longitudinal lines of narrow pale scales from near anterior margin to shortly before the prescutellar space, a small anteromedian spot of narrow pale scales, a rather broad crescent-shaped area of broad curved silvery scales on the lateral margin over *ppn* and along the scutal angle, a thin line of narrow white scales extending to the posterior margin from the end of the scutal angle, a patch of broad curved white scales before the wing base with a thin posterior extension above the wing base, and a line of narrow pale scales around the prescutellar space.

In general, the Ponape material showed the same range of variation common to *aegypti* elsewhere in its geographic range.

Bionomics.—The adults were not observed in nature. The larvae, which were taken only once, were collected from steel rain barrels.

Distribution.—SPECIMENS EXAMINED (4 males, 5 females, 9 sets of adult-associated larval and pupal skins, 4 larvae): Greenwich Village, near Colonia.

LITERATURE RECORDS FOR THE CAROLINES: Ponape (Farner, 1944a). Kusaie, Truk Atoll: Moen I. (Bohart and Ingram, 1946).

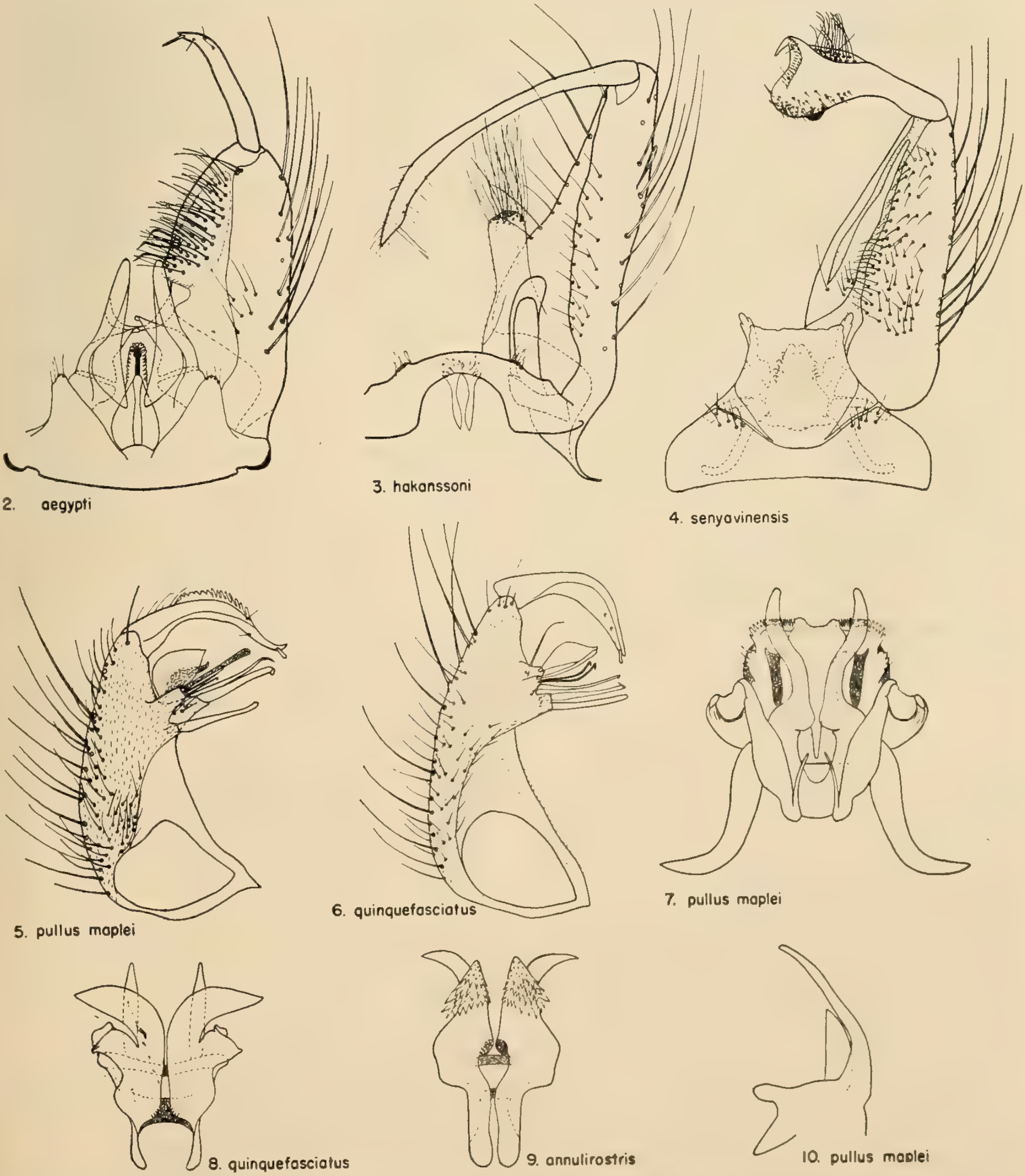
Systematics.—This species of *Stegomyia* was placed by Edwards (1932) in group A (*Stegomyia* s. str., or *aegypti*-group), which is a group composed of African species (undoubtedly the original home of *aegypti* also). The members of this group are distinct from all the Pacific species of *Stegomyia* in details of the scutal scale pattern, and in the possession of a prominent mesal-ventral arm basally on the tenth sternite.

Relation to disease.—This species is a proven vector of dengue elsewhere in the Pacific and is undoubtedly also the vector on Ponape. Epidemics of this disease occurred during the Japanese occupation of the Caroline Islands.

Aedes (Stegomyia) hakanssoni, n. sp.

Figs. 3, 11, 13, 16, 21

Adult.—A small black-and-white (the scutal pale markings yellowish) species; with a dark

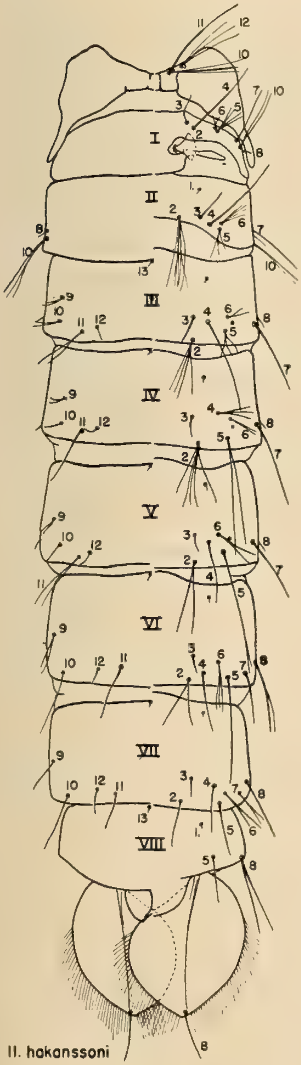


FIGS. 2–10.—Male genitalia: 2–4, Tergal aspect, left basistyle removed; 5, 6, mesal aspect of right basistyle; 7–9, sternal aspect of mesosome; 10, lateral aspect of right mesosomal lateral plate.

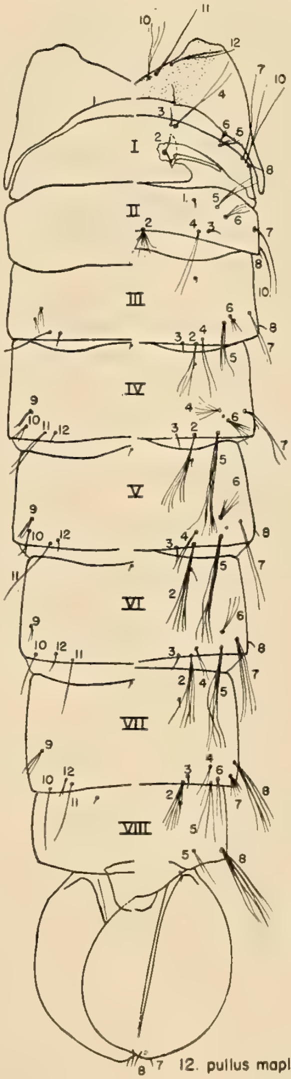
proboscis, all hind tarsal segments basally banded, vertex scales all broad, the white pleural scale patches forming two longitudinal bands across the pleuron, and prominent basolateral white spots on the tergites (becoming subbasal on the margins of the dorsum).

MALE: Length of wing about 2.0–2.5 mm. *Head:* Proboscis dark. Palpal length variable, ranging from somewhat shorter than proboscis to slightly longer; dark scaled, II with a white band just before the middle, III–V each with a basal white band, the bands on II–III incomplete ventrally, those on IV–V incomplete dorsally; IV and V somewhat upturned; a few stiff hairs apically on III–V. Torus partially clothed with broad white scales. Vertex with white or cream colored broad scales, broken on either side by two longitudinal bands of broad black scales, the alternating dark and pale bands being approximately equal in width; a line of pale scales extending along the eye margin from the subdorsal white area to the median line; some dark and pale upright forked scales on the nape. *Thorax:* Scutum with narrow black scales, prominently marked with whitish or yellowish-white scales as follows: A complete median longitudinal pale band that tapers posteriorly to the prescutellar area and there forks to the posterior margin of the scutum; a thin line of pale scales along the anterior scutal margin, over *ppn*, inward along the scutal angle and there extending posteriorly from the end of the scutal angle to the lateral scutellar lobe; and a patch of pale scales on the lateral margin just before the wing base with a thin posterior extension above the wing base; no acrostichal bristles. Scutellar lobes each with a patch of broad scales, those on the midlobe dark except for a few basal white scales (rarely no white scales), those on the lateral lobes all white. *Apn* with broad white scales; *ppn* with sparse narrow dark scales dorsally, broad white scales ventrally. Following pleural areas each with a patch of broad white scales: proepisternal, subspiracular (along the anterior margin of the sternopleuron), paratergite, dorsal sternopleural, medioposterior sternopleural, and mesepimeral (broadly V-shaped with apex directed anteriorly). The scale patches of *apn*, *ppn*, and the paratergite form an upper longitudinal pleural band and those of the proepisternum, dorsal sternopleuron, and the dorsal arm of the mesepimeral patch form a lower longitudinal pleural band. *Legs:* Forecoxa white scaled except for a median dark patch; mid coxa with white scales above and dark below, a few separate white scales dorsoposteriorly; hind coxa with white scales anteriorly, a small detached spot of white scales dorsoposteriorly. Fore and mid femora dark anteriorly except that in some cases a thin edging of white is visible along portions of the margins, prominently marked with pale scaling posteriorly. Hind femur white, with a dorsal dark area beginning subbasally or medially and widening across the anterior and posterior surfaces to just before the apex. Each of the femora with an anterior white knee spot. Tibiae dark, fore and mid with pale scales posteriorly, hind sometimes with a ventrobasal pale scaled area. Fore and mid tarsi with basal white scales on I and II, the pale spot on II consisting of only a few scales. Hind tarsus with basal white bands on I–V, that on I occupying about one-fourth of the segment, on II about one-third, on III about two-fifths, on IV a lateral patch only and varying from two- to three-fifths of the segment length, and on V a lateral patch varying from just a few basal pale scales to extending along one-half of the segment, the bands on I–III incomplete mesally. Fore and mid tarsal claws unequal, the larger unidentate, the smaller simple; hind tarsal claws equal, simple. *Wings:* Wing dark scaled; bases of fork cells approximately even; anterior fork cell approximately equal to its stem (may be up to one-third longer). Halter pale, knob largely pale scaled. *Abdomen:* Tergite I dark except for a white lateral band; II–VII dark, each marked with a prominent laterobasal white patch which extends subbasally just onto the margins of the dorsum, frequently scattered subbasal white scales across the dorsum between these dorsal extensions. Sternites with basal white bands, white scales along the midline and the posterior margins of the more basal segments. *Genitalia* (Fig. 3): Diststyle appendage subapical. Basal lobe prominent, bearing a dense apical tuft of long setae. Mesosome with about 6–8 strong teeth apically on each plate. Ninth tergite medially convex, the lobes each with a sparse tuft of small setae.

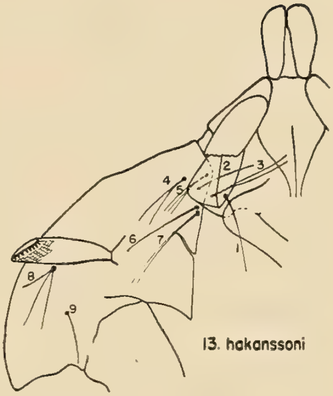
FEMALE: Length of wing about 2.7–2.9 mm. Palpus approximately one-fifth the length of the proboscis, broadly white at apex. Vertex as in male except that the median white band is only one-half as wide as the following black band. Portions of pale-scaled line over *ppn* and posteriorly from the scutal angle may be lacking. Scutellar lobes each with a patch of broad black scales, sometimes a few basal white scales present



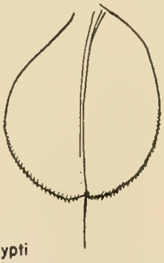
11. hakanssoni



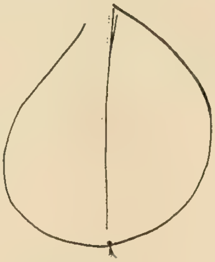
12. pullus maplei



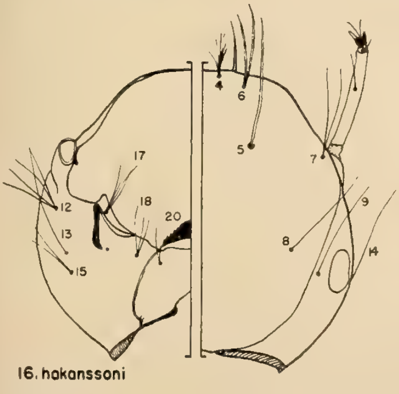
13. hakanssoni



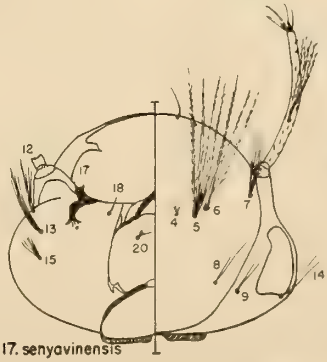
14. aegypti



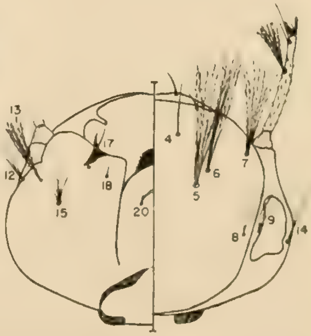
15. senyavinensis



16. hakanssoni



17. senyavinensis



18. pullus maplei

FIGS. 11–18.—11, 12, Pupa: Metathorax and abdomen, left half ventral; 13, pupa: Cephalothorax; 14, 15, pupa: Dorsal aspect of the right paddle; 16–18, larva: Head, left half ventral.

on the midlobe. Hind tarsal basal bands of II–III may be basally complete on the mesal aspect. Tarsal claws equal, simple. Wing with a dorsal spot of white scales on the base of the costa. Sternite II white scaled except for a sub-apical or apical lateral black spot; III–VI white basally, dark apically; VII with a subbasal white band.

Pupa.—Figs. 11 and 13 completely illustrate the pupa of this species. It is easily recognized by the occurrence of a prominent fringe of long hairs along the greater portion of the paddle margins.

Larva (Figs. 16 and 21).—Description based on 10 adult-associated skins, from 6 collections. *Head:* Antennal shaft short, smooth, of approximately the same diameter throughout; antennal hair inserted about midway between base and apex, single, not reaching to apex. Hair 1, slender, pointed, single; 4 with 7–12 branches; 5 and 6 single, rarely double; 7 with 1–3; 8 and 9 single; 12 with 3–5; 13 with 1–2; 14 single; 15 with 1–3; 17 with 3–4; 18 and 20 with 2–4; ventral hairs well developed. Median mouthbrush hairs with comblike tips. Mentum with 9–13 lateral teeth. *Thorax:* Prothoracic hair 0 weak, thinly stellate; 1 slender, with 3–4 branches; 2 single; 3 double; 9, 10, and 12 slender, long, unbranched; 11 short, unbranched. Mesothoracic hair 9 large, greatly elongate, with 2–7 branches; 10 and 12 large, greatly elongate, single; 11 small, single. Metathoracic hairs 9, 10, and 11 as on mesothorax; hair 12 much reduced. *Abdomen:* Dorsolateral hair of I with 3–6 branches, lateral hair of I with 1–2; lateral hair of II with 2–6; of III with 2–4; of IV and V double; of VI single. Pentad hair 1 with 3–4 branches, 3 with 4–7, 5 with 3–4. Comb consisting of a curved row of 7–11 scales, these very finely fringed along basal half. Siphon dark, index 2.0–2.5; acus lacking; hair tuft at basal four-tenths, with 4–6 branches; 9–15 pecten teeth each usually with a single ventral denticle, the teeth evenly spaced from base to basal three-tenths, the line of pecten teeth curving dorsally from the base. Anal plate incomplete; *lh* large, with 2–3 branches; *isc* with 2–4; *osc* with 2–3. Ventral brush posterior to anal plate, composed of 6–8 tufts, each tuft with 1–3 branches, lateral portion of barred area lacking. Anal gills fingerlike, the dorsal pair slightly longer than the ventral pair and approximately 1.2–2.8 times as long as the anal plate.

Types.—HOLOTYPE: Male (5-1), with associated larval and pupal skins and mounted genitalia (U.S.N.M. no. 58806), Sokas Island, Ponape Island, Caroline Island Group, January 11, 1948 (H. S. Hurlbut), reared from a banana stump. PARATYPES (15 males, 31 females, 36 sets of adult-associated larval and pupal skins, 10 larval slides): Four males, 3 females, 7 sets of associated skins, 1 larval slide, same data as for holotype; 1 male, 5 females, 5 sets of adult-associated skins, 3 larval slides, same data as for holotype except that they were reared from glass bottles; 2 males, 7 females, 6 sets of adult-associated skins, 1 larval slide, Hydroplant, Not District, Ponape Island, January 15, 1948, reared from a tree hole; 2 males, 9 females, 8 sets of adult-associated skins, 4 larval slides, Palieij, Not District, Ponape Island, January 16, 1948, reared from a steel rain barrel; 5 males, 7 females, 10 sets of adult-associated skins, 1 larval slide, Matalanim Village, Ponape Island, January 21, 1948, reared from steel barrels; 1 male, 1 set adult-associated skins, Palieij, Not District, Ponape Island, January 16, 1948, reared from water in a canoe; all of the paratypes collected by H. S. Hurlbut.

Bionomics.—The females were not observed to bite man, either in nature or in the laboratory. A few specimens were seen resting in rain barrels in which larvae were living. The larvae were collected in tree holes, glass bottles, coconut shells, steel rain barrels, and a canoe. The larvae were quite common in the rain barrels around native dwellings.

Systematics.—This new species is a member of Edwards's (1932) group C (*scutellaris*-group) of the subgenus *Stegomyia*. That group was modified by Knight and Rozeboom (1946) by removing the *albolineatus* complex and raising it to the status of a full group. In keeping with Edward's nomenclature, this new group could be named as follows: Group E (*albolineatus*-group).

Group C, modified as mentioned above, can be subdivided into three rather distinct subgroups, which are tentatively defined as follows: *Subgroup I—scutellaris* s. str. Characterized by having the more mesal portions of the abdominal tergal markings subbasal. In addition, postspiracular scales are lacking, the scutal longitudinal median line is relatively slender, and the pleural scale patches are arranged in two rather well-defined longitudinal bands (not true of *gurneyi*, however). Included species: *alorensis* Bonne-Wepster and Brug, *andrewsi* Edwards, *guamensis* Farner and Bohart, *gurneyi* Stone and Bohart, *hakanssoni*, n. sp., *hensilli* Farner, *horrescens* Edwards, *marshallensis* Stone and Bohart, *paullusi* Stone and Farner, *pernotatus* Farner and Bohart, *pseudoscutellaris* (Theobald), *quasiscutellaris* Farner and Bohart, *riversi* Bohart and Ingram, *scutellaris* (Walker), *scutoscriptus* Bohart and Ingram, and *tongae* Edwards. *Subgroup II—albopictus.* Characterized by the combination of the following: Abdominal tergal markings basal, no postspiracular scales, and the scutal longitudinal median line relatively slender. Included species: *albopictus* (Skuse), *cretinus* Edwards, *downsi* Bohart and Ingram, *flavopictus* Yamada, *galloisi* Yamada, *granti* Theobald, *novalbopictus* Barraud, *pseudalbopictus* Borel, *subalbopictus* Barraud, and (?) *unilineatus* (Theobald. *Subgroup III—mediopunctatus.* Characterized by the combination of the following: abdominal tergal markings basal, postspiracular scales present, and the scutal longitudinal median line quite broad. Included species: *mediopunctatus* Theobald, *m.* var. *submediopunctatus* Barraud, and *m.* var. *sureilensis* Barraud.

Aedes hakanssoni is most closely related to *scutoscriptus* Bohart and Ingram, a species that is known only from the Truk Atoll in the Caroline group. However, it is well distinct from *scutoscriptus* on both adult and larval characters. Both sexes of *scutoscriptus* have the scutellar lobes white scaled except for some apical black scales on the mid lobe, segment IV of the hind tarsus is all dark except for a few basal white scales, segment V of the hind tarsus is all white, and the basal bands of the hind tarsal segments are broadly interrupted mesally on I and V and narrowly so on III (complete on III in the male). Also, the lateral pale scaling that extends from the anterior margin to the scutal angle on the scutum is a solid, rather broad band in *scutoscriptus*. In *hakanssoni*, however, it is only a thin line of pale scales and with parts of it frequently obsolete altogether. The basal lobe of the male genitalia of *hakanssoni* differs distinctly from that of *scutoscriptus*, being quite similar to that of *riversi* and *hensilli*.

The larva of *scutoscriptus* is similar to that of *hakanssoni* except that head hair 6 is double, rarely single; the comb scales have a more developed lateral fringe, both dorsally and ventrally; *osc* is single (rarely divided, but not near the base); and the anal plate is more nearly complete.

Aedes hakanssoni is most easily distinguished from all the other members of subgroup I by the scutellar scaling, since they all have the scutellar scales white except for a few apical black scales on the midlobe.

This new species is dedicated to Capt. E. G. Hakansson, MC, U. S. Navy, Retired, who, as the former Medical Officer in Command of the Naval Medical Research Institute, so ably promoted this and numerous other mosquito investigations.

Aedes (Aedimorphus) senyavinensis, n. sp.

Figs. 4, 15, 17, 19

Adult.—A medium-sized dark brown species; with some pale scaling on the proboscis, dark tarsi, narrow dorsal vertex scales, 3 or 4 pleural patches of broad white scales, and basal pale bands on some tergites.

MALE: Length of wing about 2.6–2.9 mm. *Head:* Proboscis dark, frequently some ventral pale scaling at the medial joint. Palpus approximately equal in length to the proboscis, including the labella; dark scaled; apex of III slightly upturned, IV and V turned down; numerous long hairs ventrally on III, and ventrally and laterally along IV-V. Torus bare. Vertex dorsally with narrow scales, which are yellow except for a triangular median patch of dark scales just before the eye margin (the yellow scales extend to the midline along the eye margin), and dark upright forked scales; laterally with broad cream-colored scales, usually a patch of broad dark scales at the lateral margin of the dorsal narrow scaled area. *Thorax:* Scutal integument reddish brown; clothed with sparse hairlike black scales, a subdorsal patch of yellow scales extending posteriorly for a short distance from the anterior margin and a second patch on a longitudinal line with the first at the inner end of the scutal angle, also a few yellow scales medially on the anterior margin and a patch on the lateral margin just before the wing base. Each scutellar lobe with a patch of narrow black scales, usually a variable number of narrow yellow scales present basally. *Apn* with a few narrow yellow scales; *ppn* with sparse narrow dark scales, frequently a ventroposterior group of yellow scales present (may be some broadened scales in this group). Following pleural areas each with a small patch of broad white scales; dorsal sternopleural, medioposterior sternopleural, and dorsal mesepimeron. *Legs:* Forecoxa with dusky scales, mid and hind with some pale scales anteroventrally. Fore and mid femora dark scaled, prominently marked with pale scaling posteriorly; hind femur anteriorly with a ventral white area beginning near apex and widening to base, posteriorly with ventral pale scaling. Tibiae with an apical pale patch, fore and mid tibiae paler posteriorly. Tarsi dark. Fore and mid tarsal claws unequal, all unidentate except the larger claw on the mid tarsus which is simple; hind tarsal claws equal, simple. *Wings:* Wing dark scaled; base of posterior fork cell nearer wing base than that of the anterior fork cell, anterior fork cell approximately equal to its stem in length. Halter knob with dusky scaling, paler apically. *Abdomen:* Tergite I dark scaled, a small pale scaled patch on the lateral margin; II with a few median pale scales, III-VI with pale basal bands that are widened laterally, VII with a pale vaso-lateral spot. Sternites with apical dark bands, VIII all pale scaled. *Genitalia* (fig. 4): Quite distinctive in the form of the dististyle and the mesosome.

FEMALE: Length of wing about 3.6–3.8 mm. Proboscis dark, a ventral and lateral paler area from near base to shortly beyond the middle. Palpus approximately one-sixth to one-seventh the length of the proboscis, dark scaled. Torus with a few dark scales mesally. Scutal scaling as in male except that sometimes a few yellow scales are present around the prescutellar space and rarely a thin line of pale scales posteriorly from the spot at the end of the scutal angle. Proepisternum with a patch of broad white scales. Tarsal claws equal; fore and mid claws each unidentate, hind simple. Anterior fork cell about one and one-half times its stem in length. Tergites dark dorsally, a rather indistinct basal pale band on IV and sometimes on V, sometimes also a variable number of basal pale scales on III and VI, a lateral pale band on I, and a basolateral pale patch on II–VII, VIII completely withdrawn, the cerci long and protruding.

Pupa (Fig. 15).—This pupa is rather similar to that of *hakanssoni*. However, it can be separated without trouble from either that species or *aegypti* by the poorly defined paddle margin.

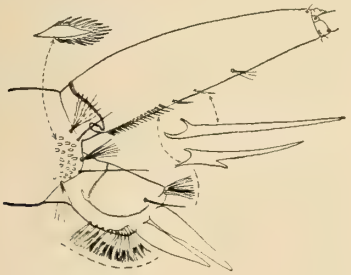
Larva (Figs. 17 and 19).—Description based on 10 adult-associated skins, from one collection. *Head:* Antennal shaft long, curved, tapered uniformly from base, sparsely spiculate laterally; hair tuft inserted at basal two-fifths, with approximately 7–10 elongate frayed branches. Hair 1 long, slender, pointed, single; 4 with 4–7 branches; 5 with 3–6; 6 with 3; 7 with 5–9; 8 with 2–4; 9 with 2–3; 12 with 4–8; 13 with 4–6; 14 with 1–3; 15 with 4–9; 17 with 1–3; 18 with 1–2; 20 with 4–6; hairs 5, 6, and 7 long, well developed, frayed. Median mouthbrush hairs with comblike tips. Mentum with 14–17 lateral teeth. *Thorax:* Prothoracic hair 0 thinly stellate in form; 1 long, slender, single; 2 with 2 or 3 branches; 3 with 2–4; 9, 10, and 12 slender, single, rarely double; 11 small, with 2–6 branches. Mesothoracic hair 9 large, greatly elongate, with 3–7 branches; 10 and 12 large, greatly elongate, single; 11 minute, with 2–5 branches. Metathoracic hairs 9, 10, and 11 as on mesothorax; hair 12 much reduced. *Abdomen:* Dorso-lateral hair of I with 3–6 branches, lateral hair of I with 1–2; lateral hair of II with 1–7; of III–VI with 1–3. Pentad hair 1 with 5–8 branches, 3 with 8–14, 5 with 4–11. Comb consisting of a patch of 29–39 scales, each scale with lateral and apical fringe. Siphon light; maximum diameter at about the basal one-fourth, index about 3.2–3.3; acus present; hair tuft at distal one-third, with 3–5 branches; 16–20 pecten teeth, the distal tooth (and often the one just basal of it) more widely spaced and without denticles, remainder evenly spaced and each with a single ventral denticle, the pecten teeth extending from base to basal two-fifths. Anal plate incomplete; *lh* with 1–2 branches; *isc* with 8–13 branches; *osc* single. Ventral brush arising posterior and ventral to anal plate, composed of 12–13 tufts, each tuft with 6–12 branches. Anal gills tapered from near base, pointed, the dorsal pair slightly longer than the ventral and approximately 1.6–1.9 times as long as the anal plate.

Types.—HOLOTYPE: Male (19–10), with associated larval and pupal skins and mounted genitalia (U. S. N. M. no. 58807), Rekisau, Not District, Ponape Island, Caroline Island Group, January 20, 1948 (H. S. Hurlbut), reared from the axils of young palms. PARATYPES: Eight males, 10 females, 15 sets of adult-associated larval and pupal skins, 4 larval slides, same data as for holotype; 1 female, with associated larval and pupal skins, 1 larval slide, Matalanim Village, Ponape Island, January 21, 1948 (H. S. Hurlbut), reared from steel rain barrel.

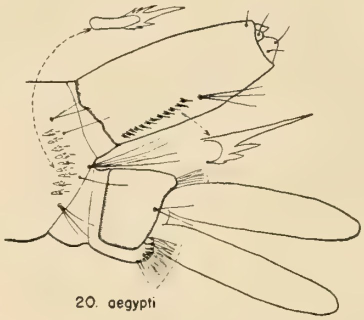
Bionomics.—The adults were not observed in nature except for one female taken in a trap baited with a live pig. The larvae were numerous in clear water collected in the axils of a group of young palms. In addition, one larval collection was made from a steel barrel containing rainwater.

Systematics.—This new species is most closely related to the species included in Edward's (1932) group C (*alboscutellatus*-group: *Aedimorphus*) of the subgenus *Aedimorphus* but is excluded from the group by Edward's definition that the scutellar scales must be broad and silvery white. However, from the fact that *punctifemore* (Ludlow) and *oakleyi* Stone are also obviously related to the species included in group C and yet are excluded on the above scutellar scale character (in neither of these two species are the scutellar scales silvery white, although they are broad), it is evident that the coloration, and probably also the shape, of the scutellar scales constitute a character of less than group value and accordingly should be omitted from the group definition.

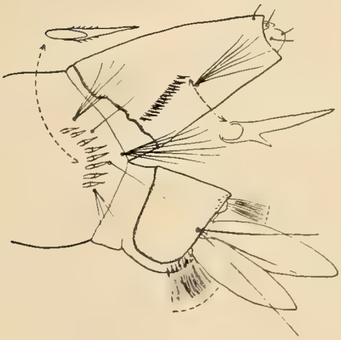
With the discard of the scutellar scale character, group D (*albocephalus*-group) is no longer sufficiently distinct from group C to justify its retention. Edwards (1932) supports this by saying that there is no sharp line of division between the two groups. Furthermore, in his 1941



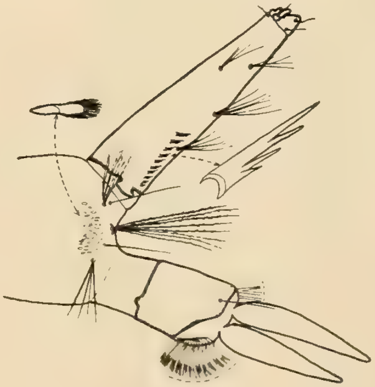
19. senyavinensis



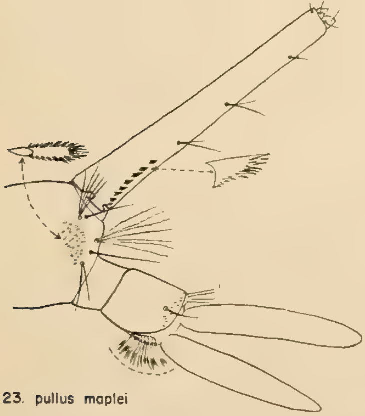
20. aegypti



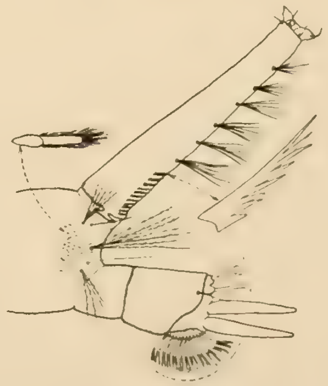
21. hakanssoni



22. quinquefasciatu.



23. pullus maplei



24. annulirostris

Figs. 19–24.—Larva: Terminal abdominal segments.

account of the Ethiopian members of the subgenus he goes so far as to redivide the African members of groups C and D into four divisions.

At any rate, until someone has an opportunity for making a new comparative study of all the species belonging to groups C and D, we prefer to treat them as a single group which we here tentatively designate as group C (*alboscutellatus-albocephalus* group). This group is separable from the others as follows: (1) Palpi of male as long as the proboscis, the last two segments noticeably hairy, and the ultimate segment not very short; and (2) the basistyle with basal lobe small or absent. Included species: *alboscutellatus* (Theobald), *culicinus* Edwards, *jamesi* (Edwards), *lowisi* (Theobald), *niveoscutella* (Theobald), *oakleyi* Stone, *orbitae* Edwards, *pampangensis* (Ludlow), *punctifemore* (Ludlow), and *senyavinensis*, n. sp. Unfortunately, the male of *ostentatio* (Leicester) is still unknown so that even its inclusion in the subgenus *Aedimorphus* is doubtful. Pending publication of a male description, the exact position of *wainwrighti* Baisas is also still uncertain but it is clearly not a member of group C.

Aedes senyavinensis is probably most closely related to *oakleyi* Stone, a species known only from Guam. In the adult, *oakleyi* is most distinct in having the scutellum covered with shining creamy broad scales. Also, *apn* possesses pale broad appressed scales, and the abdominal tergites of the female have prominent basal bands. In general, the adult of *oakleyi* is much paler than that of *senyavinensis*. The male genitalia of *oakleyi* is similar to that of *senyavinensis* except for the chaetotaxy of the dististyle, where some small differences occur. The larva of *oakleyi* has been described by Bohart and Ingram (1946) and from their description differs as follows from the larva of *senyavinensis:* head hair 6 double, the mentum with 18 or 19 lateral teeth, pentad hair 2 with about 3 branches, and the siphon index about 4.0–4.5.

This new species is most easily distinguished from all the other Australasian and Oriental members of group C, except *culicinus*, on the scutellar scaling, since all the others have the scutellar scales broad, or nearly all so. Although no specimens of *culicinus* were available for comparison, differences in the spines and hairs of the dististyle are evident from Barraud's (1934) figure. The larva of *culicinus* is undescribed.

This species is named after the Senyavin Islands, which is the eastern island group in the Carolines that includes the island of Ponape.

Culex (Culex) quinquefasciatus Say

Figs. 6, 8, 22

A medium-sized brown species; with dark proboscis and tarsi, narrow dorsal vertex scales, several pleural patches of broad white scales, and prominent basal creamy bands on tergites II–VII.

Although all the Ponape specimens examined came from only three larval collections, all the commonly reported adult and larval variations of *quinquefasciatus* were represented. No significant differences were noted between the Ponape specimens of *quinquefasciatus* and those described from other portions of its range.

Bionomics.—The adults were observed biting man soon after sunset and their biting activity continued through the night and early morning before sunrise. They were rarely found resting in native houses during the day. A few were seen near the entrance of caves; and a few were caught in a light trap, in a trap baited with a live pig, and in small wooden kegs placed under native houses. They were never taken in numbers except while biting in the evening.

The larvae were collected in water receptacles such as steel barrels, cement tanks, tin cans, and coconut shells near dwellings. In depositing their eggs, the females showed a preference for polluted water.

Distribution.—SPECIMENS EXAMINED (3 males, 17 females, 20 sets of adult-associated larval and pupal skins, 3 larval slides): Colonia, Sokas Island, Palikir, and Matalanim Village.

LITERATURE RECORDS FOR THE CAROLINES: Kusaie, Ponape, Woleai, and Palau (Farner, 1944a). Truk Atoll, Ulithi Atoll, and the Palau Group (Bohart and Ingram, 1946).

Relation to disease.—Filariasis is common on Ponape and this mosquito is probably the vector. Under experimental conditions, *quinquefasciatus* is capable of transmitting Japanese encephalitis. However, this disease is now known to occur in Ponape.

Culex (Culex) annulirostris Skuse

Figs. 9, 24

A medium-sized brown or blackish species; with white-banded proboscis and tarsi, narrow dorsal vertex scales, several pleural patches of broadened pale scales, and prominent basal creamy or yellowish bands on tergites II–VII.

The pupa of this species may be distinguished from that of either *quinquefasciatus* or *maplei* by the number of branches possessed by hair 5 on abdominal segments IV–VI: hair 5 on segment IV with 5–8 branches (usually 5–6), on segment V with 2–3, and on VI double. The two terminal hairs on each paddle are approximately equal in length.

No significant differences were noted between the adults of *annulirostris* from Ponape and those described from other portions of its range, except, that, in general the scutal scaling (particularly of the female) is darker, the abdominal banding is yellower, and the pale spots of scales are largely lacking from the anterior aspect of the fore tibia.

Several minor differences in the larvae have been noted. Woodhill and Pasfield (1941) reported Australian material as having a siphon index of approximately 7.2, and the anal gills only 0.6–0.8 times the length of the anal plate. These observations are corroborated by Lee (1944), also from Australia. On the other hand, Cooling (1924) describes the siphon index of Australian material as about 5.0–5.5 (also described head hair 7 as having 11–12 branches); Buxton and Hopkins (1925) of Samoan material as about 5.1; and Bohart and Ingram (1946) of specimens from Truk as about 6. The siphon index of the Ponape material is 4.1–5.3 (head hair 7 with 6–9 branches). On the basis of these records, and from observations made by the senior author in the New Hebrides, it is apparent that there is a considerable range of natural variation in the siphon index of this species. From the literature records mentioned above it is also apparent that the anal gills are variable in length (1.5–2.0 times longer than the anal plate in Ponape material), but no correlation between this character and the geographical distribution of the species is possible at present.

Bionomics.—The females are commonly observed biting man soon after sunset, and their activity continued throughout the evening. They were captured in great numbers in a trap baited with a live pig, as many as 400 being taken in a single overnight catch.

The larvae were collected in clean water in ditches containing emergent vegetation, in small marshy areas containing algae and emergent vegetation, in shallow wells open to sunlight, in small cement tanks containing algae, and in a rock pool containing algae.

Distribution.—Specimens examined (9 males, 16 females, 22 sets of adult-associated larval and pupal skins, 7 larvae): Colonia, Sokas Island, Matalanim Village, and Ronkiti.

Literature records for the Carolines: Truk Atoll and Ulithi Atoll (Bohart and Ingram, 1946).

Systematics.—Of the *Culex* (*Culex*) species with banded proboscis, *annulirostris* is probably most closely related to *sitiens* Wiedemann, from which it is distinct on characters of the male genitalia and of the larva. There are undoubtedly valid adult coloration differences, but since both species are subject to natural variations in the intensity of the color pattern (particularly of the scales of the vertex, scutum, and abdomen) these are rather unsafe for use until more comprehensive studies, covering all portions of the geographical range of the two species, are made.

Culex annulirostris marianae Bohart and Ingram, from the Marianas, is subspecifically distinct in possessing an apical line of pale scales on tergites II–IV, and sometimes also on V–VI. The anal gills are usually shorter, frequently much shorter, than the anal plate.

Culex (Culiciomyia) pullus maplei, n. subsp.

Figs. 5, 7, 10, 12, 18, 23

Adult.—A medium-sized brown species; with dark proboscis and tarsi, some broad dorsal vertex scales, and prominent basal creamy bands on tergites III–VII; and without scales on the pleuron. Pleuron pale, prominently marked by two longitudinal broad dark bands (integumental), the ventral one terminating medially on the sternopleuron.

Male: Length of wing about 3.0 mm. *Head:* Proboscis dark, a prominent ventral tuft of bristles medially (just before the labial joint), numerous short hairs all along the proboscis. Palpus longer than the proboscis, including labella, by approximately the length of the last segment; dark scaled; II–III straight, usually directed obliquely away from the proboscis and IV–V directed obliquely inward toward the proboscis; III with a rather sparse ventral row of long modified scales from near base to apex, these modified scales hairlike except for being broadened and flattened medially, numerous long hairs ventrolaterally and mesally along IV–V. Torus bare. Vertex covered with broad creamy scales, dorsum with dusky upright forked scales (the more anterior ones paler) and with a band of narrow creamy scales on the nape and more sparsely on the longitudinal midline. *Thorax:* Scutum with fine brownish narrow scales. Scutellar lobe with pale narrow scales. *Apn* bare of scales; *ppn* with some narrow brownish scales dorsally. No pleural scale patches. Single lower mesepimeral bristle present. Pleural integument pale; marked with a prominent longitudinal dark brown band beginning on *ppn* and txtending across the postspiracular, prealar (beeow the knob), and upper mesepimeral areas; and a second shorter one below, beginning on the proepisternum and extending about halfway across the medial portion of the sternopleuron. *Legs:* Forecoxa with dusky scales anteriorly; mid with a few dusky scales anteriorly; hind bare of scales. Fore and mid femora dark scaled, marked with pale scaling posteriorly; hind femur pale scaled, anteriorly with dark scaling dorsally from near base to apex, posteriorly the apical two-fifths is largely dusky. Tibiae and tarsi dark. Fore and mid tarsal claws unequal, each unidentate; hind tarsal claws equal, simple. *Wings:* Wing dark scaled; base of fork cells approximately even, anterior fork cell noticeably longer than stem. Halter knob with grayish scales. *Abdomen:* Tergite I with a median area of dark scales; II dark scaled; III–VII with broad basal creamy or yellowish bands, on the more posterior segments these bands are narrowed medially, all the bands extending onto the lateral aspect. Sternites II–III pale scaled, IV–VII with pale scales basally and dark scales apically. *Genitalia* (Figs. 5, 7, 10): Identical with that of *pullus*, the genitalia of which has been illustrated by King and Hoogstraal (1946). Their drawing of the basistyle of *pullus* is a lateral view and shows the distinctive hair tuft that is present at the level of the subapical lobes. This is also present in *maplei* but is not visible in the mesal view given in Fig. 5 of this paper. Their drawing of *pullus* fails to show one of the three appendages (the curled-tipped or shortest one) always possessed by the most distal-mesal lobe. This setalike appendage is difficult to locate unless stained. Also, the irregular subapical lateral lobe of the tenth sternite is omitted in their drawing.

Female: Length of wing about 3.2–3.8 mm. Proboscis without a special hair tuft. Palpus approximately one-sixth the length of the proboscis, dark. Torus with dusky scales and hairs mesally. Vertex as in male except that the narrow scaled dorsal area is more extensive. Forked upright scales golden brown. Scutellar scales approximately the same shade of color as those of the scutum. Tarsal claws equal, simple. Stem of anterior fork cell only slightly more than one-half as long as the cell. Basal band on tergite VII frequently broken medially; tergite VIII dark. Sternite scales may be nearly all pale. Ocassionally a thin apical pale line of scales on some tergites. *Variations:* Two female specimens of the series studied completely lacked the basal band on tergite III.

Pupa (Fig. 12).—This pupa may be distinguished from that of the other two *Culex* species treated in this paper by the number of branches possessed by hair 5 on abdominal segments IV–VI: hair 5 on segment IV with 4 or 5 branches, on V with 3–6 (5–6 branched in 20 out of 22 examples), and on VI with 3–7 (usually 5–6, and with 3 branches only once out of 22 examples). It is also distinct in the lack of pigment on the lateral half, or more, of the metathorax. The two terminal hairs on each paddle are approximately equal in length.

Larva (Figs. 18, 23).—Description based on 10 adult-associated skins, from 4 collections. *Head:* Antennal shaft spiculate and somewhat broadened from base to level of hair tuft, slenderer and mostly free of spicules from there to apex; hair tuft inserted just before apical one-third, with approximately 15 elongate frayed branches; subapical bristles distinctly removed from apex. Hair 1 elongate, slender, single (once forked); 4 single; 5 with 4–7 branches; 6 with 3 or 4; 7 with 8–11; 8 with 2; 9 with 3–7; 12 with 3–5; 13 with 2–5; 14 with 1–3; 15 with 4–7; 17 and 18 single; 20 with 3–6; hairs 5, 6, and 7 prominently frayed. Median mouthbrush hairs with comblike tips. Mentum with 13–15 lateral teeth. *Thorax:* Prothoracic hair 0 thinly stellate in form; 1, 2, and 3 greatly elongate, single; hairs 9 and 10 slender, single; hair 11 small, with 4–7 branches; hair 12 large, greatly elongate, single. Mesothoracic hair 9 greatly elongate, with 4–5 branches; 10 and 12 large, greatly elongate, single; 11 minute, with 3–4. Metathoracic hairs 9, 10, and 11 (with 2–5 branches) as on mesothorax; hair 12 much reduced in length, slender, single. *Abdomen:* Dorsolateral hair of I with 2–4 branches, lateral hair of I double; lateral hair of II with 3 (once 4); of III–VI double. Pentad hair 1 with 5–7 branches, 3 with 6–8; 5 with 2–3. Comb consisting of a patch of approximately 32–37 scales, each scale with a complete lateral and apical fringe. Sipon pale; index 6.0–10.6; acus present; 3 hair tufts (once 4 on one side) present, the first inserted just beyond the most apical pecten tooth and the last near the apex, each with 2 or 3 branches (once single and once with 4); 8–15 pecten teeth, each tooth with a complete ventral fringe of denticles. Anal plate complete; pale; with small denticles lateroposteriorly; *lh* single; *isc* single, *osc* single. Ventral brush composed of 8 tufts arising from a barred area posterior to the anal plate, each tuft with 3–6 branches. Anal gills somewhat fingerlike, the dorsal pair 2.0–2.6 times as long as the anal plate and just slightly longer than the ventral pair. *Variations:* A rather extensive range in the siphon index was the most important larval variation noted.

Types.—HOLOTYPE: Male (30–9), with associated larval and pupal skins and mounted genitalia (U. S. N. M. no. 58808), Sokas Island, Ponape Island, Caroline Island Group, January 27, 1948 (H. S. Hurlbut), reared from a taro axil. PARATYPES (13 males, 19 females, 31 sets of adult-associated larval and pupal skins, 5 larval slides): Seven males, 5 females, 11 sets of associated skins, 1 larval slide, same data as for holotype; 2 males, 7 females, 9 sets of associated skins, 1 larval slide, Colonia, Ponape Island, January 10, 1948, reared from a tin can; 1 female with associated skins, 2 larval slides, Palieij, Not District, Ponape Island, January 16, 1948, reared from a steel tub; 4 males, 6 females, 10 sets of associated skins, 1 larval slide, Matalanim Village, Ponape Island, Jan. 21, 1948, reared from steel barrels; all the paratypes collected by Hurlbut.

Bionomics.—The adults were not collected in nature. Caged females reared in the laboratory failed to take blood from a mouse during several overnight exposures, nor would they bite man. The larvae were very numerous in artificial containers around native dwellings, often being found in polluted water in tin cans and steel drums along with *quinquefasciatus*, and in cement tanks in the foundations of destroyed Japanese houses. Two larval collections were made from water collected in the leaf axils of taro plants. The egg rafts were easily distinguished from those of *quinquefasciatus* by their shape, the former being roughly circular in outline while the latter are elongate with pointed ends.

Systematics. The adult described above is well distinct from all of the known Pacific *Culiciomyia* species[4] except *pullus* Theobald. From this species it is distinguishable only in the larval stage. The larva of *pullus*, although definitely similar in general form, is distinct in having a transverse unsclerotized band in the siphon (also true of *nigropunctatus*). Fourteen larval specimens of *pullus* from Guadalcanal, Solomons; Hollandia, New Guinea; and Morotai, Moluccas disclosed the following additional differences from *maplei:* head hair 5 triple (once with 4 branches), and the lateral hair of abdominal segments III–VI single.

Because the differences between *pullus* and the Ponape species occur only in the larval stage, and because the two species are geographically separate, it was thought best to name the latter as a subspecies of the first.

Bohart and Ingram (1946) report a larval collection (no adults were obtained) from the Palau Group which could be either *pullus* or *nigropunctatus* (the larvae of the two being undistinguishable at present). This is the only other record of a *Culiciomyia* from the Caroline Islands. The range of *pullus* extends from the Solomons through New Guinea and Australia to the Moluccas, and that of *nigropunctatus* from the Celebes to India and the Philippines. These two species are well distinct from one another on male genitalic characters.

This new species is dedicated to Dr. John D. Maple, II, formerly of the Bureau of Entomology and Plant Quarantine, and of the U. S. Navy, who lost his life on April 11, 1945, while engaged in mosquito research duties on Okinawa.

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[4] The following 14 species of *Culiciomyia* are at present recognized from the Pacific area: *bahri* Edwards, *bailyi* Barraud, *fragilis* Ludlow, *fuscicinctus* King and Hoogstraal, *javanensis* Bonne-Wepster, *nailoni* King and Hoogstraal, *nigropunctatus* Edwards, *pallidothorax* Theobald, *papuensis* (Taylor), *pullus* Theobald, *ryukyensis* Bohart, *shebbearei* Barraud, *spathifurca* Edwards, and *viridiventer* Giles.

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HERPETOLOGY.—*Miscellaneous notes on Mexican lizards.*[1]

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For a number of years I have been accumulating notes on lizards of Mexico for use in a report upon the collections secured from 1938 to 1940 by my wife and me during my tenure of the Walter Rathbone Bacon Traveling Scholarship of the Smithsonian Institution. Preparation of a checklist of Mexican lizards prior to completion of this report requires preliminary publication of certain portions of these notes.

Unless otherwise stated, the specimens cited in the following pages are part of the collections mentioned previously, now part of the U. S. National Museum collection, to which the numbers refer. Other abbreviations are: EHT-HMS, the Taylor-Smith collection, at the University of Kansas; CNHM, Chicago Natural History Museum.

I am indebted to Dr. Edward H. Taylor, Dr. Doris M. Cochran, Karl P. Schmidt, and Dr. L. C. Stuart for numerous courtesies contributing to the collection and study of the material here reported.

Sphaerodactylus glaucus glaucus Cope

One hundred and sixteen typical specimens (see below) were secured at the following localities: VERACRUZ: Tezonapa (no. 113086). TABASCO: Álvaro Obregón (Frontera) (nos. 113096–120); Emiliano Zapata (Montecristo) (no. 113095); Tenosique (nos. 113087–94). GUATEMALA: Piedras Negras, Petén (nos. 113084–5).

All except a few from Piedras Negras were caught in towns, under loose bark of trees or in houses. On May 13, 1939, large quantities of eggs nearly ready to hatch, as well as adults, were found under the loose flakes of bark on trees in the central park of Álvaro Obregón. Many of the eggs that were retained hatched within a day or two. Generally two eggs were found in a clutch, although sometimes as many as six or eight, presumably from several females, were found in a single spot. The eggs were nearly perfect spheres and were protected by a very brittle shell.

The adults of the east-coast race of this species are characterized by generally having a small black spot middorsally on the neck; a black spot on each side of rump, above insertion of hind leg, each bordered posteriorly by a light spot; a light spot on knees and sometimes elbows; a distinct, light band across distal portion of thighs and lower foreleg; and a distinct light line on posterior surface of thigh, extending onto base of tail.

Young specimens are similarly marked, although a little darker and with numerous very tiny white flecks scattered over the back. The only great difference from the adults in markings is in the neck region. A series of small rounded light spots encircles the dorsal and lateral surfaces of the neck a short distance in front of the arm insertion; the two most prominent spots are those on each side of the middorsal line. Surrounding the spots is an irregular band of black; its most prominent portion is a spot between and slightly anterior to the larger, paravertebral light spots. Specimens of larger size lose all these neck markings save the median dark spot.

A series of atypical specimens is available from various localities near Tehuantepec (La Presa de Mixtequilla, Cerro Guengola, Cajón de Piedra) as well as from the city itself (nos. 113139–63). These differ from typical *glaucus* by lacking any distinct light and dark marks in the adult; even the very young show no distinct markings. These might be considered racially distinct from *g. glaucus*, except for two adult specimens which possess an irregular, black, double collar about the neck. These definitely link the Tehuantepec series with the west-coast race *torquatus*, typical specimens of which are available from more remote localities on the Isthmus toward the coast west of Salina Cruz. The latter race also is

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[1] Received September 3, 1948.

characterized by absence of the distinctive markings of *g. glaucus*, but adds a new character in the possession of two broad, distinct black collars about the neck. In the area in which they occur on the Isthmus, on the coast southwest of Tehuantepec, they exist to the almost total exclusion of the unicolor type which occurs around Tehuantepec city; in fact only two specimens of the latter were said to be collected with the collared specimens. Since the collared specimens possibly range rather widely on the Pacific coast northwest of the Isthmus, as indicated by the type locality of *torquatus* at "Mazatlán" (Sinaloa?); and since the unicolored or typical *glaucus* type of pattern rarely if ever occurs with the collared specimens, there is ample reason to hold the latter as racially distinct from the others. In fact, Taylor (Univ. Kansas Sci. Bull. **31:** 302–305. 1947) has already demonstrated the distinctness of *torquatus*.

The unicolored specimens from the vicinity of Tehuantepec are, I believe, essentially intergrades between typical *glaucus* and *g. torquatus;* certainly they are intermediate both geographically and in pattern; they lack the characteristic collar of *torquatus*, yet like it are practically unicolored otherwise, contrary to *glaucus* which has distinct leg and neck markings. If Peters's *inornatus* from "Mexico" actually belongs to *glaucus* and is not a *lineolatus* with incorrect locality data as suggested by Barbour (Mem. Mus. Comp. Zool. **48:** 240. 1921), it may be based on the unicolored intergrades between *g. glaucus* and *g. torquatus*, from the vicinity of Tehuantepec.

The U. S. National Museum has 20 others, as follows: CAMPECHE: Apazote (no. 47796). OAXACA: Juchitán (nos. 30235–8). TABASCO: Álvaro Obregón (nos. 37749–51, 46694, 81166). VERACRUZ: Coatzacoalcos River (nos. 61184–5); Tuxpan (no. 25215). YUCATÁN: Mérida (nos. 6572, 62995–6); Cozumel Island (no. 47644). INDEFINITE: "Mexico" (nos. 96108–10).

Sphaerodactylus glaucus torquatus Strauch

Twelve specimens are from Cajón de Piedra (nos. 113126–33) and El Limón (no. 113134), Oaxaca. Both localities are near the coast west of Salina Cruz.

Corythophanes percarinatus Duméril

A single specimen (no. 113171) is from Colonia Hidalgo, 8 kilometers north of La Esperanza, Chiapas. It differs from a single specimen available from "Guatemala" (no. 25217) by having a blunter snout, smaller temporals, head scales less strongly keeled posteriorly, and scales on shank and thigh much smaller. Further specimens will be necessary to show whether these differences are due to individual variation; that they might have little significance is shown by considerable individual variation in *cristatus*, in which the temporal, thigh and shank scales vary considerably in size.

The species has not previously been recorded from Mexico.

Ctenosaura similis (Gray)

Thirty-eight specimens were secured, at the following localities: CHIAPAS: Palenque (nos. 115310–7); Tonalá (nos. 115318–30); La Esperanza (nos. 115331–3). TABASCO: Tenosique (nos. 115306–9).

These specimens agree sufficiently well with the characters described by Bailey (Proc. U. S. Nat. Mus. **73** (12): 32–37, pls. 16–20. 1928) for this very distinct species. In addition to his observations it may be noted that in females the dark bands so characteristic of males are broken and frequently so dim as to be scarcely discernible. The pattern in these usually consists of numerous, scattered, short black lines. The head is mostly light in males as a rule, but regularly in females and rarely in males also the head is largely dark.

There are very obvious differences between the skulls of *similis* and those of *acanthura* and *pectinata*.

Other Mexican specimens in the U. S. National Museum number 34. They are from the following localities: VERACRUZ: Mirador (no. 6403). YUCATÁN: Merida (nos. 8220–1); Chichen-Itzá (nos. 47794, 47953–5, 47992–3); La Vega (no. 47564; Puerto Morelos (no. 47647); Mujeres Island (nos. 47559–63); Cozumel Island (nos. 13897–13900, 47565) "Yucatán" (nos. 24724–5, 24898). CHIAPAS: Palenque (no. 47593); Tonalá (nos. 46685, 46693). TABASCO: Montecristo (Emiliano Zapata) (nos. 47793, 47802). INDEFINITE: "Mexico" (nos. 11002–3); "Tehuantepec" (nos. 10286, 56782, 58499). Some of these were not listed by Bailey (*op. cit.*); others were associated with the wrong numbers, and the one from "Mirador," Veracruz, was associated by him with *acanthura*. It is definitely not the latter, since the tail spines are smaller, no two whorls of spines are separated from each other by a single row of small scales, the sides are barred (juvenile female), and the distance from pineal spot to posterior margin of head is short. It is not necessarily certain that the specimen came from Mirador, but at least the existence of *similis* in the region of central Veracruz is demonstrated by adults from Tierra Colorada, near the city of Veracruz (EHT-HMS collection, see Smith, Kans. Univ. Sci. Bull., **22:** 139–140. 1935). The specimens labelled "Tehuantepec" (Dr. Spear and J. Hurter) do not necessarily imply the city of Tehuantepec, where the species apparently does not occur, but rather the Isthmus.

Ctenosaura acanthura (Shaw)

Only four specimens were secured, at Hda. La Clementina, 4 miles west of Forlón, Tamaulipas (no. 115259) and 10 miles east of San Juan de la Punta, Veracruz (no. 115260).

The museum has 27 other specimens, as follows: Tamaulipas: Tampico (nos. 36261–4, 36408, 36628, 36672, 36862–5, 37008, 37356). Veracruz: Panuco River, 80 miles above Tampico (nos. 26316, 26323, 26340–1); between Tampico and Veracruz (nos. 82181–3). Oaxaca: Dondominguillo (no. 72737). Indefinite: "Mexico" (nos. 42145–6, 42842, 44179, 82184); "Tehuantepec" (no. 58498). Some of these were listed by Bailey (*op. cit.*); the others were omitted. However, Bailey included, in his list of *acanthura*, one *similis* from Veracruz (no. 6403) and several *pectinata* (*sensu lato*) from Isabel Island and the Tres Marías Islands, and from the states of Guerrero, Oaxaca, and Michoacán. The specimen labeled "Tehuantepec" (J. Hurter) almost certainly does not refer to Tehuantepec City, where intensive collecting in recent years has failed to verify its existence in the region, but rather to the Isthmus.

Why several west-coast *pectinata* were included by Bailey in *acanthura* is not readily apparent. Not a single one can be referred to that species; none of the adults are black; none have large spines on the tail; and none have the small scales between any pair of whorls of large scales reduced to a single row at any point. There is no reason whatever to believe that *acanthura* occurs on the Pacific coast, so far as indicated by specimens now in the National Museum. The species appears to be perfectly well defined and restricted to the Atlantic coast from the Isthmus of Tehuantepec north to central Tamaulipas. It occurs in the same general area as *similis*, but its range appears to overlap that of no other species.

Ctenosaura pectinata (Wiegmann)

Fifty-one specimens were secured, at the following localities: Guerrero: Acapulco (no. 115274); Cacahuamilpa (nos. 115277–82); 20 km north of Mexcala (nos. 115275–6); Tierra Colorada (nos. 115261–73). Michoacán: 4 km north of Apatzingán (nos. 115299–302); Parácuaro (no. 115298). Morelos: 5 km south of Cuernavaca (nos. 115295–7); Puente de Ixtla (nos. 115303–5). Oaxaca: Cerro Arenal (no. 115283); El Limón (no. 115294); Escurana (nos. 115292–3); San Bartolo (no. 115291); San Gerónimo Ixtepec (no. 115290); Santiago Lachiguiri; Tehuantepec (nos. 115284–9).

The Museum has 163 other specimens as follows: Sinaloa: Mazatlán (nos. 7180–3, 47956–7); Culiacán (no. 70665). Nayarit: Tres Marías Islands (nos. 14078, 72655–7); Maria Madre Island, Tres Marías (nos. 24623–30, 71634–5); Isabel Island (nos. 24631–3); Minimán (no. 51402); San Blas (nos. 51403–7, 65138, 76613–8); "Tepic" (no. 58753). Jalisco: Barranca Ībarra (nos. 18967, 18970, 19032); Guadalajara (nos. 24922–3); San Marcos (nos. 18968–9). Colima: Colima (nos. 12196, 24708–17, 24719–23, 24726, 30594–603, 31484, 58670, 63702–31, 63734–68); Manzanillo (no. 63701); Tonila (nos. 63732–3). Michoacán: Sierra Madre (no. 12230; Uruapan (no. 10234). Guerrero: Balsas (nos. 47919–20, 58137); Tlapa (no. 46860). Morelos: 10 miles south of Cuernavaca (nos. 20168–72). Puebla: Piaxtla (no. 47729). Oaxaca: Cuicatlan (nos. 46835, 47194); Guichicovi (no. 47933); Juchitán (no. 72738); Tehuantepec (nos. 7533–4, 30430). Indefinite: "Mexico" (nos. 31286, 83330).

The various specimens from the west coast of Mexico south of Sonora variously assigned by Bailey (*loc. cit.*) to *acanthura, brachylopha, brevirostris, parkeri*, and *pectinata* all belong, I believe, to a single species. All the specimens in the U. S. National Museum assigned by him to these various names have been examined, and I can see no justification whatever for segregating them into so many species. That his arrangement is highly artificial and not a natural one (i.e., of true species and subspecies) is made immediately obvious by the recognition of several "species" from single localities. *C. similis* and *acanthura* may occur in the same locality, but this is the only recognized instance in which two species of the same group have overlapping ranges, and even this is doubtful because of the considerable competition. But that *four* species (*parkeri*, *pectinata, brachylopha, acanthura*), all of the same group, should inhabit such restricted areas as the Tres Marías Islands, is preposterous. There are other cases of several species cited by Bailey from single localities. The reason for such segregation without regard to geography and the natural history of the subject, is apparently due to the overemphasis of certain "key" characters which were assumed not to vary but which actually do, to a considerable degree. The five anatomical categories given the rank of species are:

1. "Median row of dorsal scales interrupted at sacrum."
    2. "First and second or first, second, and third whorls of spinous scales interspersed with three rows of small flat scales". . ... *acanthura*
    2.′ "First, second, third, fourth, and fifth whorls of spinous scales interspersed with three rows of small flat scales". . ... *brachylapha*

1.′ "Median row of dorsal scales enlarged and extending from nape to tail, without interruption at sacrum."
    3. "Head very short, rostrum conspicuously decurved"................ *brevirostris*
    3.′ "Head normal, rostrum not conspicuously decurved."
        4. "First six whorls of spinous scales of the tail separated from each other by four or more rows of small flat, smooth scales"............ *parkeri*
        4.′ "First five or six whorls of spinous scales separated from each other by three rows of smaller scales, the next five or six whorls being separated from each other by two rows of smaller, flat scales"........ *pectinata*

The first division is impractical. The character is of aid in separating certain species of the genus, but in the area in question specimens show both extremes and all intermediates. In 28 specimens from Guerrero and Morelos, 8 have the series of enlarged middorsals passing over the sacral region without interruption; in the others the series is narrowly interrupted by as few as two small scales, or broadly interrupted by as many as 20 small scales. In one of five specimens from Michoacán, the series is complete in one, interrupted by 9 to 16 scales in the others. In 15 specimens from Oaxaca, the sacral series is uninterrupted in four, and interrupted by one to 14 scales in the others. The variation is such that it seems impossible to believe that this criterion has any significance. There is no correlation of the variation with other scale characters or with color.

By literal adherence to the word in the second division, no west-coast specimens could be associated with *acanthura*, but by the same interpretation neither could true *acanthura*. In the latter species the tail spines are stronger, longer, and more erect; the small scales between at least one or more pairs of whorls of enlarged spines are rarely not reduced to one row; adults and subadults (both sexes) become black by a general darkening of the whole body (not by encroachment of black upon spots that remain light, as in *pectinata*); and the reduction to two rows of the small scales between the whorls of enlarged scales begins with the second or third pair. Specimens agreeing with these characters are not represented in those examined from the Pacific coast, and there is good reason to believe the species does not exist there.

The third division, separating *brevirostris*, does not seem to me to have any support whatever even in the material assigned by Bailey to the two categories. The heads of presumed "*brevirostris*" specimens are in no respect whatever, so far as I can see, shorter than those of *pectinata*. It is true that the two cotypes superficially appear to have short heads, but the snout of one obviously has been pushed in, while the other has a partly broken skull.

The last division, segregating *parkeri*, is the most nearly feasible of all, but even this, I believe, has no special significance. Three paratypes cited by Bailey are from "Tres Marías, Nayarit," which means the Tres Marías Islands, where Bailey also distinguished *pectinata, brachylopha*, and *acanthura*. There is no geographic sense whatever in the existence of such a species, so very close in all characters but one to the specimens secured in the same localities, in two so very different spots—Barranca Îbarra, Jalisco (just north of Guadalajara), and on the Tres Marías Islands. The Tres Marías specimens obviously represent nothing but variations of the single species that occur on the islands, and I regard the Barranca Îbarra specimens in the same light. It is noteworthy that Bailey did not associate with the latter another specimen (U.S.N.M. no. 19032) of the same series and with the same data. It is true, however, that all of the three Barranca Îbarra specimens have *parts* (in most cases the extra row is reduced a few scales on each side of the middorsal row) of a fourth row intercalated between the proximal whorls of enlarged spines, while the same character is occasional in its occurrence elsewhere.

Two specimens (from Guerrero and Oaxaca) have portions of a fourth row intercalated between the basal five whorls of spines; in two others (Oaxaca, Guerrero) it occurs between the first, second, and third whorls; in two others recorded the extra row occurs only between the first and second whorls. These data indicate that the Barranca Ībarra specimens may uniformly be provided with four rows between the proximal whorls of spines, and thus deserve a name; it is also possible that the three specimens do not give a fair representation of the local variation, which may well actually be the same as elsewhere. Against the recognition of a local race at Barranca Ībarra is the fact that *Ctenosaura* does not incline toward formation of such restricted populations. Its members otherwise have large geographic ranges representing major faunal areas.

The elimination of such a miscellany of supposed species on the Pacific coast makes very clear and reasonable the distribution of the species of *Ctenosaura* in Mexico. *C. hemilopha* occurs in Baja California and Sonora, and southward is replaced by *pectinata*, which occurs from central Sinaloa to the Isthmus of Tehuantepec. Beyond the Isthmus (toward Central America), on both coasts, *similis* occurs to the exclusion of all others of its group; it extends northward on the Atlantic coast to central Veracruz. Here it either overlaps or dovetails into the range of *acanthura*, which occurs from Oaxaca (Dondominguillo) northward to central Tamaulipas. The only conspicuous overlapping of ranges occurs between members of different groups; i.e., the species *clarki*, *quinquecarinata*, *erythromelas*, and *defensor* belong to quite a different group than the others; they are of different habitus, size and habits, and occur commonly over broad areas occupied by *acanthura* and its relatives.

Phrynosoma boucardii (Bocourt)

One fine example is from Zimapán, Hidalgo (no. 111370). The U. S. National Museum has no others of the species.

This specimen differs from *orbiculare*, which it closely resembles, in the large size of the postorbital, temporal and occipital spines, the feeble keels on the gular scales, and the nearly erect position of the occipital spines. It measures 79 mm from snout to vent; the frontal region is strongly concave, the superciliary regions elevated and terminating posteriorly in a relatively large spine measuring a maximum of about 3.5 mm. The occipital spines are 5.8 mm long (maximum), and their posterior edges make an angle of about 75° with the horizontal, while the temporal spines are at an angle much less than 45°. The temporal spines extend farther posterior than the occipital (because of their nearly horizontal position), and the posterior measures 5.7 mm (maximum). The posterior infralabials, the postaurals and the subpostaurals are conspicuously enlarged. The gulars are feebly keeled.

Sceloporus malachiticus acanthinus (Günther)

Thirty-one specimens are from La Esperanza, Las Nubes, Salto de Agua, Cruz de Piedra, Finca Juárez, Rancho Las Gradas, and La Magnolia, all in the vicinity of Escuintla, Chiapas (nos. 112112–40; EHT-HMS 17046–7).

The dorsals vary from 34 to 39 (except in two, noted below), average 36.7 (34, two; 35, four; 36, eight; 37, six; 38, four; 39, five); femoral pores 12 to 16, average 13.7 (12, nine; 13, sixteen; 14, seventeen; 15, twelve; 16, two): there are two canthals, but in seven the anterior is forced above the canthal ridge; the median frontonasal is in contact with the lateral frontonasal in all except one side of one, both sides of four; one or more supraoculars are in contact with the median head scales in all except on one side of one, on both sides of another; the supraoculars are partially split (small outer scales) in one; the lorilabials are reduced to one row below the subocular on one side in three, on both sides in two; there are 3 scales (minimum) from median frontonasal to rostral in twenty, 4 in seven.

The most interesting of this series are 12 from Finca Juárez. This locality is at 2,500 to 3,000 feet in elevation, as high as or higher than any other at which *acanthinus* was secured. Seven of these are more or less typical of the subspecies, while the other five show so many combinations of characters of *taeniocnemis* and *acanthinus* that they must be considered intergrades. Two of them have small outer supraoculars; three have the median frontonasal separated from the lateral frontonasals on both sides, and one specimen on one side; three have four scales from the median frontonasal to the rostral and one has five; one has the aberrant count of 42 dorsals and another has 45. None of these can be considered typical *taeniocnemis*, although all approach the sum character of that race in a varying number of respects. I can see no alternative to the conclusion that these represent intergrades, that *acanthinus* and *taeniocnemis* intergrade, and therefore that the former must be removed from the *spinosus* group and placed in the *formosus* group.

All specimens were found on the trunks of large trees. They were very wary and seldom seen except when we were specifically hunting them.

In addition to these are six noteworthy specimens (EHT-HMS X5020–4) from La Gloria, Oaxaca. This locality is on the east side of the Isthmus of Tehuantepec, almost directly north of Niltepec, but in the moist, high forest on the Atlantic slope, at about 1,500 feet elevation. The specimens were collected by Thomas MacDougall on dead, burned tree trunks in open cornfields recently cleared from the forest. They have 35 to 40 dorsals (35, 36, 37, 40, 40); 10 to 13 femoral pores (10-10, 11-?, 11-11, 11-12, 11-12, 13-13); two canthals; median frontonasal separated from laterals; large supraoculars in a single row and not in contact with median head scales, sometimes the outer row represented by one or two small scales split from "inner" row; lorilabials in two complete rows below subocular; and 4 to 6 scales (minimum counts) from median frontonasal to rostral (4, 5, 5, 5, 5, 6). The only adult (a female) measures 83 mm snout to vent; the others are juveniles. The color above is gray (no trace of blue), with a row of brownish spots on either side of middorsum, each spot covering about three scales; a feebly indicated, black, dorsal nuchal collar, visible also on sides of gular region; in the adult female a faint indication of the characteristic, broad, short, dark, median borders of the lateral belly patches occurring in males of this group.

The proper allocation of the La Gloria series is not too obvious. The specimens can not be associated with *taeniocnemis*, since this is a highlands species with divided supraoculars, much blue in the coloration, smaller dorsals, more numerous femoral pores, and no distinct rows of large spots. They can not be associated with *salvini*, which also has more numerous dorsals and in addition a complete nuchal collar. Although the large supraoculars and larger dorsals are reminiscent of *acanthinus*, the latter race has large frontonasals in contact with each other, and the supraoculars generally in contact with the median head scales.

Because of the impossibility of association of the La Gloria specimens with typical members of other races in adjoining areas, they might be considered as representing still a different race. In support of this view are the peculiar, very small, rounded scales in the internasal area; rare specimens of *taeniocnemis* show a similar condition, but otherwise it is unique. However, it seems more probable to me that the La Gloria specimens represent intergrades between *acanthinus* and *salvini;* they combine the characters of these two races and show no peculiarities not existing in one race or the other, except for the small internasals as previously mentioned. La Gloria is also geographically intermediate between the known ranges of the two races. Therefore, until further specimens from other localities, especially in western Chiapas (both Atlantic and Pacific slopes), indicate otherwise, it appears best to consider the La Gloria specimens as intergrades between *acanthinus* and *salvini.*

Sceloporus malachiticus taeniocnemis Cope

Fifteen specimens (nos. 112141–54) were secured at an elevation of about 5,500 to 6,500 feet on Mount Ovando, near La Esperanza, Chiapas. The adults are greenish above, as are the *acanthinus*. The dorsals vary from 37 to 47, average 41 (37, one; 38, one; 39, three; 40, one; 41, three; 42, two; 44, two; 47, one); the femoral pores are 11 to 15, average 12.6 (11, one; 12, eleven; 13, nine; 14, two; 15, one); the canthals 2-2, the anterior forced above the canthal ridge on one side in one; the median frontonasal is in contact with the laterals on both sides of two, on one side in one; there are 3 to 5 scales from rostral to median frontonasal (3, four; 4, eight; 5, three); one or more supraoculars are in contact with the median head scales in two; the supraoculars are in a single row on one side of three, on both sides of two; there are two complete rows of lorilabials below subocular on one side in two, on both sides in three.

The type of *taeniocnemis* (U.S.N.M. no. 24768, "Guatemala", collected by H. Hague) is a juvenile measuring 39 mm snout to vent, with all the outer scales missing; dorsals 40; femoral pores 13 or 14; two distinct rows of supraoculars; median head scales much subdivided; 4 scales from median frontonasal to rostral; lateral frontonasals separated from median; two complete rows of lorilabials; canthals 2-2.

Through the courtesy of Dr. L. C. Stuart I have had the privilege of examining a series of 20 specimens from Finca Samac, near Cobán, Alta Verapaz, and 3 others from the vicinity of Nebaj, El Quiche, Guatemala, all collected by him. The former series may be considered topotypic, since Hague is known to have collected in Alta Verapaz, and since the type of *taeniocnemis* agrees in detail with several young from Finca Samac. I can not distinguish these specimens from those from Mount Ovando by any character which can not be attributed to the influence of adjacent forms, or which to my mind is significant. The specimens from Guatemala never have single supraoculars nor a number of other variants which occur in the Mount Ovando series; however, their existence in the latter is almost certainly due to the influence of the closely associated race *acanthinus*, which *taeniocnemis* approaches in character toward the edge of its range. The only peculiarity I have discovered by which the Mount Ovando series differs from that from Guatemala is in the reduction in the former of the lorilabials to one row at some point below the subocular. I do not believe this difference sufficiently significant or well established to warrant an attempt to split *taeniocnemis;* if other minor differences should be discerned, the two populations are so alike, compared with other subspecies of *malachiticus*, that they can not in any circumstance be considered equivalent of *smaragdinus*, *salvini*, *acanthinus*, etc.

Other specimens which must be referred to *taeniocnemis* are three from Cobán, Guatemala (C.N.H.M. 20533, 21003; A.N.S.P. 11316); one from Teopisca (between San Cristóbal and Comitán), Chiapas (U.S.N.M. no. 47503); and three from Pinobete, 8,400–8,800 feet, Chiapas (U.S.N.M. nos. 47761–3). The race has a central distribution on the highlands to the west and north of the range of *smaragdinus*.

The latter subspecies includes specimens from the central plateau of Guatemala and its projections; they are characterized by small size, numerous dorsals (39 to 51), and a single canthal. Females measuring no more than 52 mm snout to vent contain young in the uteri.

Leiolopisma assatum assatum (Cope)

Fifty-five specimens were secured, all in the state of Chiapas in the vicinity of La Esperanza (La Esperanza, Cruz de Piedra, Salto de Agua, Rancho Las Gradas, La Magnolia, nos. 115204–39). The U. S. National Museum has in addition one other specimen from Huehuetán, Chiapas (no. 47758). In 52 counts, the rows of dorsals vary from 29 to 37 (29, two; 30, thirty-two; 31, two; 32, sixteen). In 49 counts, the dorsals from parietals to posterior margin of thighs are 65 to 77, average 71.0 (65, one; 66, one; 67, three; 68, three; 69, seven; 70, six; 71, eight; 72, five; 73, six; 74, four; 75, three; 76, one; 77, one).

This species was most frequently encountered on the ground in coffee groves. In the dry season, when the ground is covered with a thick layer of dry leaves and there are no low plants to obstruct vision, they were easily captured by walking slowly through the leaves and watching closely for their wriggling, scampering bodies as they scurried out from the leaves near at hand and dived under others a few feet away. It was necessary to fall on the lizards immediately as they appeared, as otherwise they hid in the leaves and were almost impossible to find.

Leiolopisma assatum taylori Oliver

Nineteen specimens referred to this race were collected: GUERRERO: Agua del Obispo (nos. 115240–1); Tierra Colorada (no. 115242). OAXACA: Matias Romero (nos. 115243–6). CHIAPAS: Tonalá (nos. 115247–58). In addition the U. S. National Museum has one from "Mexico" (no. 46866) and 13 from "Tehuantepec," Oaxaca (nos. 30101–7, 30109–13, 30170).

The single specimen without definite locality data has 24 scale rows. The three from Guerrero have 26 (two) and 28; the dorsals are 69 (two) and 72; two have a nuchal on both sides, and one has one on only one side. The four from Matías Romero have 26 and 28 (three) scale rows; the dorsals are 68, 71 and 72 (two); two have nuchals, but in one of these on one side only; the other two have no nuchals. In the thirteen from "Tehuantepec," the scale rows are 26 (two), 28 (ten) and 30 (one). In the 12 from Tonalá, the scale rows are 26 (one), 28 (six) and 30 (four); the dorsals 66 (two), 68 (one), 69 (three), 70 (one), 71 (one), 72 (one) and 73 (one); three have nuchals on both sides, one has one on one side, and the remainder (eight) have none. The closest approach to *a. assatum*, as might be expected, is shown by the southernmost specimens, from Tonalá, in which the scale row counts of *a. assatum* occur in 33 percent of the specimens. The dorsal scale counts of the two races blend over quite a large area, since even the Guerrero specimens are within the lower limits of the range of variation in typical *a. assatum*.

Leiolopisma gemmingeri (Cope)

Sixteen specimens were secured, as follows: OAXACA: 17 miles north of Niltepec, on south side of Sierra Madre, in pine forest at 3,500 feet elevation (nos. 115195–6); San José Manteca, 5 km from Yautepec (no. 115194); Tres Cruces (nos. 115188–93). VERACRUZ: Tequeyutepec (nos. 115197–203). In addition the U. S. National Museum has four cotypes from Orizaba, Veracruz (no. 6331), one from Río Verde (Veracruz) (no. 32372), and one from an unknown locality ("Panama," J. Hurter) (no. 56976).

In 20 of these specimens (excluding no. 32372, not seen), the scale rows vary from 25 to 28 (25, one; 26, five; 27, two; 28, eleven); and the dorsals from 60 to 68 (60, one; 61, one; 62, eight; 63, two; 64, two; 65, one; 67, one; 68, three). The color pattern is constant, save that in the specimens from Tres Cruces and San José Manteca the only portion of the lateral dark stripes that is well defined is the extreme upper edge; in the others the stripe is very dark throughout most of its width.

Leiolopisma silvicolum Taylor

The U. S. National Museum has two specimens belonging to the recently described *Leiolopisma silvicolum* Taylor (Copeia, 1937, no. 1: 5–7), known previously only from the type locality near San José de Gracia, Veracruz. They are no. 12092, from "Mexico," and no. 47611, from Cuicatlán, Oaxaca. Both have 30 scale rows and the limbs strongly overlapping, as do the two types. The lateral dark stripe is poorly defined posteriorly.

Measurement	No. 12092	No. 47611
Snout to vent	44.5 mm	47.0 mm
Hind leg	18.4 mm	17.5 mm
Fore leg	11.0 mm	12.5 mm
Axilla to groin	23.0 mm	27.0 mm
Dorsals	68	64

Eumeces lynxe Wiegmann

Twenty-seven specimens were secured, at Durango, Hidalgo (nos. 113576–82); Pan de Olla, Veracruz (nos. 113583–600); and Cruz Blanca, Veracruz (no. 113601).

Four specimens (one from Hidalgo, three from Pan de Olla) have three supraoculars as is typical of the variant named *furcirostris;* in these, of course, the large anterior supraocular is in contact with the parietals. In 11 other specimens (2 from Hidalgo, 8 from Pan de Olla, 1 from Cruz Blanca) the largest (second) supraocular also touches the prefrontals as in *furcirostris*, but a small supraocular is present between the second supraocular and first superciliary. In two others (Hidalgo and Pan de Olla) the second supraocular contacts the prefrontal on one side, is narrowly separated on the other. In the remaining nine, the prefrontals are broadly or narrowly separated from the second supraocular.

The U. S. National Museum has one other specimen (no. 14605) from "Mexico."

Eumeces sumichrasti (Cope)

Ten specimens are from Piedras Negras, Guatemala (nos. 113609–12), Palenque, Chiapas (nos. 113613–5), and La Esperanza, Chiapas (nos. 113616–7).

The only difference apparent between the Pacific and Atlantic coast specimens is in the longer retention by the former of the juvenile stripes. An adult from La Esperanza measuring 75.4 mm from snout to vent still retains very distinct, dark-edged light stripes, while a specimen from Piedras Negras measuring 66.5 mm. snout to vent shows no trace of the median stripe and very faint evidence of the dorsolateral light stripes.

The scale rows about the middle of the body vary from 26 to 30 (26, one; 28, two; 30, four).

The Museum has one other, the type (no. 6601), from Potrero, Veracruz.

Cnemidophorus sackii sackii Wiegmann

Through the courtesy of Dr. Robert Mertens I have recently received two photographs of the single type of *Cnemidophorus sackii* Wiegmann. These were furnished through the kindness of Dr. Eisentraut, of the Zoological Museum in Berlin. He reports that the type bears the collection number 884.

Comparison of these photographs (Fig. 1) with those reproduced in Gadow's monograph (Proc. Zool. Soc. London, 1906: 277–375) reveals a remarkable similarity to some individuals of his race *C. mexicanus balsas*, and especially to specimen C of text figure 83. No other race closely approaches the type in details of pattern. It is of special interest to note the origin of specimen C; it is from Cuernavaca, Morelos, a city through which Deppe most certainly passed enroute from Mexico City to Acapulco (see Bailey, Proc. U. S. Nat. Mus. **73** (12): 5. 1928). Not unreasonably it may be supposed that the type of *C. sackii* actually was collected near Cuernavaca. Inasmuch as no *more* reasonable locality can be anticipated, I hereby restrict the type locality of *Cnemidophorus sackii* Wiegmann to Cuernavaca, Morelos.

The form recognized by Gadow as *C. mexicanus balsas* thus becomes a synonym of *C. sackii sackii.* A tentative arrangement of subspecies will be proposed in the checklist of lizards now in preparation.

Bipes canaliculatus Lacépède

In 1932 Edward H. Taylor and I secured 15 specimens of this species, two of which were presented to the Museum of the Instituto de Biología in Mexico City, and one of which was prepared as a skeleton. All were taken in one small area near the Balsas River in Guerrero at the junction of the same with the Mexico-Acapulco highway. They were found under the large, weathered, sandstone rocks characteristic of the slopes exposed by erosion of arroyos and larger streams. Fortunately, the collecting followed a rather heavy shower, which, as the region is semiarid and very barren, evidently is of no frequent occurrence. The surface of the ground was quite dry even after a day's exposure to the sun, but under the larger, coarse stones the soil remained moist, and here, especially under those stones at the base of trees and bushes, were the lizards found. Frequently they had made long, winding burrows in the soil just under the rocks, and occasionally one would be found with only a small portion of the body above the ground and in contact with the lower surfaces of the rocks. The burrows were so characteristic that in many cases it could be observed that the lizards had at some time been present under rocks where none were then to be found. Presumably these creatures follow the level of moisture, and if it is raised to the surface or near it by a heavy shower, they should then be found under rocks more frequently than at any other time. During the dry season it is probable that only rarely would they be found in the upper, dry soil strata, except perhaps at night. Attempts to find them at night above ground were futile; in fact, one specimen was found under a rock at night. A local farmer said he occasionally plowed them up in his field, located in the flood plain of a stream entering the Río Balsas.

The intestinal contents of several specimens consisted largely of the elytrae and legs of Coleoptera.

When crawling about in the hands, the forelegs were frequently if not usually kept in active use, especially when the animals attempted to burrow or pry through small openings.

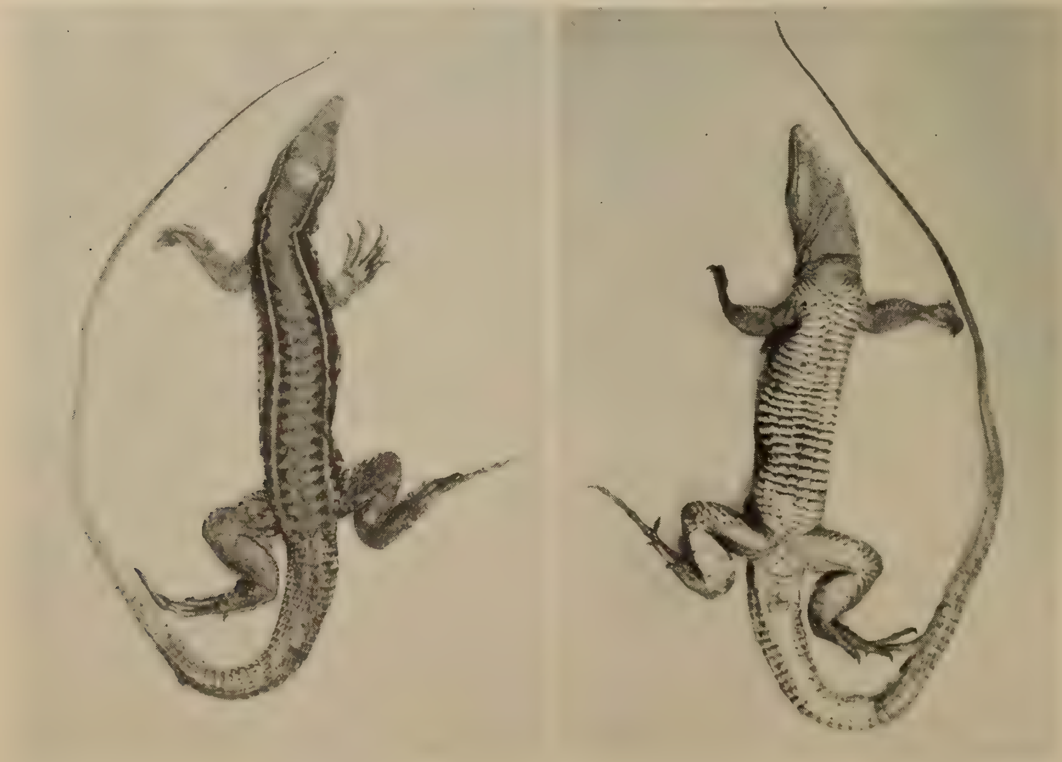

FIG. 1.—*Cnemidophorus sackii* Wiegmann, type, Zool. Mus. Berlin no. 884.

Cope (1898) placed his *Bipes biporus* in the monotypic genus *Euchirotes*, distinguishing the two genera (*Bipes* and *Euchirotes*) largely on the basis of the presence of a claw on the fifth digit of *Euchirotes*, the absence in *Bipes*. In two of our specimens, these claws are distinctly present, although small, and thus the character previously considered of generic value is shown to be even specifically variable. *B. biporus*, however, remains distinct from *canaliculatus* on the basis of other characters.

The following table gives general features of scalation and proportion:

VARIATION IN BIPES CANALICULATUS

No.	Ventral annuli on body	Ventral annuli on tail	Dorsal annuli	Pre-anal pores	Snout to vent	Tail	Head to occiput
					Mm	*Mm*	*Mm*
795	154	32+	197	6	158.8	24.0	8.0
966	154	29+	195	6	166.5	26.4	7.5
968	152	30+	194	6	166.5	24.8	8.0
969	149	30+	199	6	167.0	25.4	8.0
799	163	34+	200	6	170.0	27.0	8.0
800	152	32+	198	6	180.0	26.8	8.0
967	153	—	195	6	180.7	—	8.1
798	158	32+	199	6	181.0	28.0	8.0
797	162	—	198	6	185.0	—	8.2
964	156	32	200	6	190.0	29.0	8.0
796	155	—	196	6	192.0	—	8.3
965	164	35+	201	6	192.0	30.1	8.0

Two small frontals; a very large prefrontal; a large rostral; two nasals, somewhat smaller than rostral, nostrils perforating them nearer anterior edge; two large upper and two large lower labials, followed in each case by two smaller labials scarcely or no larger than scales of temporal region; eye in an ocular scale surrounded by a single preocular, two suboculars, and bordered posteriorly by two other small scales, all subequal; a large mental, smaller than rostral, and bordered posteriorly by another scale somewhat smaller, this in turn bordered on each side by a scale somewhat smaller and in contact with lower labials; dorsal annuli separated from ventral annuli very abruptly on a lateral line on each side; dorsal surface of limbs with about 6 annuli; digits 2–4 with 3 dorsal, 4 ventral scales, first digits with 2 dorsal, 3 ventral scales; a short gular fold between and in front of arms; latter 5–6 mm long in our specimens.

Color in life, uniform light brown above, lighter between annuli and between scales forming annuli; head in front of eyes, brownish cream, ventral surfaces pink, lighter to white posteriorly, limbs especially pink.

But little variation obtains in the scutellation of head, quite uniform in all except one in which on each side is a minute scale against the nasal between the second upper labial and preocular, another in which the left supraocular of each side is partially fused with the prefrontal, and another in which the right frontal was broken up into small scales, possibly due to injury.

Xenosaurus rackhami Stuart

A single specimen (no. 111524) of this species, of which only the type from Guatemala has previously been described, was presented me by Sr. Rafael Martín del Campo, of the Instituto de Biología in Mexico City. It was collected by Mario del Toro Áviles at Santa Rosa, near Comitán, Chiapas, during the summer (June to August) of 1937.

It agrees with the description of *rackhami* in the relatively large size of the gular scales, close approximation of the enlarged tubercles on the forearm, and the broad, low character of the tubercles on the body. I count 34 transverse rows of abdominal scales from axilla to groin. The species' most distinctive feature is the large size of the gular scales.

HERPETOLOGY.—*The validity of relative head width in defining the races of* Ambystoma macrodactylum.[1] M. B. MITTLEMAN, New Rochelle, N. Y. (Communicated by HERBERT FRIEDMANN.)

In a recent paper (1948) I presented the results of an investigation into certain aspects of the morphological variation of the salamander *Ambystoma macrodactylum*. Although several characters were studied, only three were found to display any variation significantly associated with geographic origin. These important variables are: Vomerine tooth counts, proportion of head width to head length, and proportion of head width to snout-vent length. The variations of these three characters are associated with certain geographic populations of *Ambystoma macrodactylum*, such that when the definitive range of variation for each character is calculated for specimens from each of two general geographic areas in the over-all distribution of the species (*sensu lato*), it is possible to identify not less than 71 per cent of more than 300 specimens as to geographic origin, on the basis of any one of these discrete variables. Taken collectively, the three criteria together with certain color and pattern differences, will correctly identify the provenance of at least 85 per cent of the specimens seen in the course of this study.

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[1] Received October 20, 1948.

In view of the highly significant association between these criteria and certain geographic populations, two races of *Ambystoma macrodactylum* were recognized: the typical form, *A. macrodactylum macrodactylum* Baird, occupying the Columbia Plateaus Province and the Northern Basin and Range Province in Washington and Oregon, and extending through the Cascade-Sierra Province from northern California to southern and western British Columbia; also a race, *A. macrodactylum krausei* Peters, occupying the Northern Rocky Mountains Province in Idaho and Montana, southwestern Alberta, eastern and northern British Columbia, and questionably extending east to Iowa.

In studying the relative head widths of the various samples used in this investigation, it was found that the ratio of head width to snout-vent length (hereafter called HW/SV ratio) provided a useful index to proportionate head width. However, two major types of variation were at once discernible: ontogenetic and geographic. It was found that when eastern and western specimens of equal snout-vent length were compared, eastern specimens tended usually to have proportionately narrower heads (lower HW/SV ratio) than did western specimens (higher HW/SV ratio). Despite the fact that this difference in HW/SV ratio between strictly comparable specimens provided a useful dichotomous character for discriminating between eastern and western specimens, its use was complicated by virtue of the fact that a prominent intra-population ontogenetic variation in the HW/SV ratio was present simultaneously. In brief, it was not possible to distinguish between the eastern and western populations merely by stating that population "X" had an HW/SV ratio of so much or more, while population "Y" had an HW/SV ratio of so-and-so or less, since the ratio itself changes very drastically as the animal grows and matures beyond the post-metamorphic stage.

The HW/SV ratio gradually diminishes from about 20 per cent in young, recently metamorphosed animals, to about 15 per cent in fully mature specimens, thus indicating that the head becomes progressively narrower relative to the snout-vent length as the animal grows in size.

Hence, in order to utilize dichotomously the differential in HW/SV ratio which was found in comparable specimens of the eastern and western populations, it was necessary to employ some device which would distinguish between the two populations, regardless of the size of the specimen(s) involved, and thereby circumvent the intrapopulation ontogenetic trend. The simplest solution to the problem was the utilization of a formulary device, based on the independent variable (snout-vent length), which could be applied to any snout-vent length and produce a fixed mathematical value. With such a value available, a dichotomous character results, for it is then possible to say that for any given snout-vent length population "X" has an HW/SV ratio (or head width) greater than the computed formulary value, while population "Y" has an HW/SV ratio (or head width) less than the formulary value. Such a formula was computed for comparing raw head width measurements, and another, derivative formula was likewise developed for comparing relative head widths (HW/SV ratios). These two formulas are respectively:

$$(2 \log SV)^2 - (\log SV)^2 \tag{1}$$

$$\frac{(2 \log SV)^2 - (\log SV)^2}{SV} \tag{2}$$

The application of the first formula to any particular snout-vent length results in a mathematical value which may be conveniently visualized as the "standard" head width for that snout-vent length. The application of the second formula to a given snout-vent length produces a value which may be considered the "standard" HW/SV ratio for that snout-vent length. In eastern specimens (*A. m. krausei*), the head width and the HW/SV ratio are usually less than the value obtained from either of the two formulas, while in western specimens (*A. m. macrodactylum*) the head width and the HW/SV ratio tend to be higher than the formulary values. The formulas produce about the same degree of satisfactory separation of the two populations. In my original paper (*op. cit.*) I published a graph based on the first formula used in conjunction with 86 specimens equally divided between the eastern and western populations. That the formula is a satisfactory dichotomous device, and that the two populations have significantly different head widths when strictly comparable specimens are examined, is reflected in the fact that 61 out of the 86 specimens used (= 71 per cent) in preparing the graph are correctly separated by the curve computed from the formula. When this result is tested by chi-square to determine if it could have been fortuitous or resulted from a significant association between head width size and geographic origin, a chi-square value of 17.7 is obtained, indicating a highly significant association between the variable (head width) and geographic origin.

More recently, Joshua L. Baily, Jr., has reviewed my study of *Ambystoma macrodactylum*, with especial attention to the problem of the significance of the differences existing between the head widths of eastern and western specimens. Mr. Baily's paper includes an excellent discussion of some properties of the arithmetic mean, and of another average, the trigonometric mean, but does not appear to contribute in any way to the problem at hand. Baily states in the beginning of his paper (1948, p. 171) that he is inclined to question whether my material adequately demonstrates a real difference in head width in the salamanders under discussion, but in the conclusion of his paper (p. 174) Baily says that confirmation is given to my conclusion that Idaho specimens have narrower heads than do specimens from Oregon and Washington, subject to certain limitations.

Baily has attacked the problem of determining whether a significant head width difference exists between these two populations through the medium of comparing certain means, and the differences between these means. His results show that there exists a significant difference between the means of the HW/SV ratios of the two populations, whether the arithmetic mean or the trigonometric mean is used. However, although Baily's results confirm my original contention, his use of means to investigate the problem is open to serious question. When organisms display a strong ontogenetic variation in certain structural characters, as do these salamanders, the comparison of means based on these characters and predicated on random samples seems to me to be essentially meaningless. To have any true biological and statistical significance, such means must properly be based on equal numbers of specimens of each of the two populations or samples, for any given size class. Baily drew his data from the graph published in my original paper (*loc. cit.*), but it will be noted that the 43 Idaho specimens used in preparing this graph range from 41 to 59 mm in snout-vent length, while the 43 Oregon and Washington specimens vary from 40 to 68 mm, with not less than 10 out of the 43 western specimens being 60 mm$^+$ in length. As I have pointed out, the tendency in these ambystomids is to develop a proportionately narrower head as the snout-vent length increases. Hence, with 23 per cent of the Oregon-Washington sample of greater length than any available Idaho specimens (of those used in preparing the graph), means of the HW/SV ratios of these two samples would be biased toward a relatively lower figure for the western (Oregon-Washington) specimens than that obtained for the eastern (Idaho) specimens, and hence the difference between these means would tend to diminish. That the difference between these means is still significant, as Baily found, is strong confirmation of the real difference in head width in these two populations. Had there been Idaho specimens in the 60–68 mm range, the difference would probably have been even greater, as it would likewise have been if the Oregon-Washington specimens in the 60–80 mm range had been deleted from Baily's computations; with strictly comparable numbers of specimens from each of the two samples available for each size class, the difference would have been still greater. In any event, a far better procedure for the determination of the significance of the difference in head width in these two populations would be to use a test such as the chi-square, or the standard error of the difference between the regression coefficients (of the head width—snout-vent regression of each sample).

In his conclusion, Baily states that my original finding respecting the difference in head width is confirmed "subject to limitations hereinbefore noted." The only possibly pertinent limitation Baily has noted, is that in my original paper I stated that the populations representing the races *krausei* and *macrodactylum* are homogeneous *intra se*, whereas Baily says that despite significant differences in the head widths of the two samples there may be local races of *macrodactylum* which do not differ from the Idaho (*krausei*) population in the same manner as the samples from Oregon and Washington which were used in this study. This is of course a distinct possibility; however, in the course of my investigation numerous intrapopulational comparisons of various criteria were made, and in no instance did the results suggest any other conclusion but that *krausei* and *macrodactylum* are composed of homogeneous populations, as defined in my paper.

In closing his paper, Baily points out what appears to be a *lapsus* on my part, in that the formula used in my graph is amenable to simplification, and can be reduced to—

$$\frac{6 \log (SV)}{SV}$$

However, this is the formula for a ratio, whereas the formula used in my graph is that of a simple equation. Baily goes on to state that my formula produces a "standard" head width—which is correct so far as the formula used for the graph is concerned. But obviously, in presenting his apparently simpler formula, he has reference to the second of my two formulas given above, which yields a "standard" HW/SV ratio, not a "standard" head width. In any event, Baily's formula produces an arithmetic result completely incompatible with either of my formulas, and the value obtained has no pertinency in the present problem.

Despite Baily's contentions to the contrary, the apparently straight line in my graph is a portion of a curve, and this curve passes through the common origin of both the HW and SV scales, if the graph is expanded so that both the abscissa and ordinate scales start at zero values. This curve is not asymptotic, as Baily maintains, since a zero value of SV will produce a zero formulary value, thus causing the curve to pass through the common origin of both scales of the graph.

SUMMARY

1. The problem of the dichotomous utilization of an ontogenetic variable, specifically the HW/SV ratio in *Ambystoma macrodactylum*, is discussed. The significant difference in the head widths of specimens of comparable snout-vent lengths of *A. m. krausei* and *A. m. macrodactylum* is reaffirmed, as is also the usefulness of the formula $(2 \log SV)^2 - (\log SV)^2$ in defining dichotomously the head widths of specimens of any snout-vent length.

2. Joshua L. Baily's use of various means to analyse the differences in head widths of *A. m. krausei* and *A. m. macrodactylum* is discussed, and the limitations involved in the use of means predicated on ontogenetically-variable ratios are pointed out.

3. Baily's contention of a *lapsus* in my original paper is refuted, his confusion of two formulas is pointed out, and it is noted that my curve is non-asymptotic, and that the formula from which it is derived is not amenable to further simplification.

LITERATURE CITED

BAILY, JOSHUA L., JR. *Supplementary observations on the geographic variation of* Ambystoma macrodactylum. Herpetologica **4**: 171–174. 1948.

MITTLEMAN, M. B. *American Caudata: II, Geographic variation in* Ambystoma macrodactylum. Herpetologica **4**: 81–95, fig. 1. 1948.

PROCEEDINGS OF THE ACADEMY

421ST MEETING OF BOARD OF MANAGERS

The 421st meeting of the Board of Managers, held in the Cosmos Club, October 18, 1948, was called to order at 8:05 p.m. by the President, Dr. F. D. Rossini. Others present were: W. L. Schmitt, F. G. Brickwedde, W. W. Diehl, F. M. Defandorf, W. N. Fenton, Walter Ramberg, T. Dale Stewart, C. F. W. Muesebeck, W. W. Rubey, F. O. Coe, M. A. Mason, H. G. Dorsey, C. L. Gazin, and, by invitation, R. J. Seeger, Alan Stone, and Frank Thone.

The chairman of the Committee on Meetings, Dr. Raymond J. Seeger, announced that Dr. Trytten, of the National Research Council, had been secured as speaker for the October meeting of the Academy and that he would talk on *Scientific personnel problems of today*. He also announced that Dr. Bacher, of the Atomic Energy Commission, would speak on atomic-energy research at the November meeting.

Five persons were elected to resident membership and one to nonresident membership.

The chairman of the Special Committee on the Encouragement of Science Talent in the schools of the Washington area, Dr. Martin A. Mason, presented the following report:

The Special Committee on Encouragement of Science Talent in the schools of the Washington area, appointed June 9, 1948, has the pleasure of presenting herewith its report.

The Committee has interpreted its function to be the development of firm recommendations for action in the immediate or near future but not necessarily to consider the ways and means by which action can be taken. Further, it has been assumed that the schools referred to are public, private, or sectarian high schools, colleges and universities within the boundaries of the District of Columbia.

It is the opinion of the committee that recognition of science talent is a necessary first part of any program of science talent encouragement. The limited resources, both financial and human, of the Academy impose the necessity of expending those resources only for the encouragement and fostering of a certain demonstrated minimum science talent rather than in a broad program looking toward recognition and development of all latent science talent in the area. The committee states its opinion that recognition of talent should occur during the early years of high school, with encouragement of the recognized talent reaching a maximum of effort in the high school-college transition years, continuing at high level through the sophomore college year, then decreasing to a minimum at the baccalaureate stage. This system would provide for discovery of talent at the earliest practicable stage of its development and insure maximum encouragement at the most critical period of the potential scientist's career. The committee has considered the problems involved in the discovery and recognition of scientific talent.

It has been the experience of others who have engaged the problem of recognition of talent that the use of tests, competitive exhibitions of the products of talent, and similar means of selection is difficult, requires elaborate staging with an accompanying large expenditure of time and effort, and is quite expensive. The committee doubts that the Academy would desire or is in a position to undertake an independent talent search of the required magnitude. As an alternative the desirability of affiliating with the National Science Talent Search, sponsored by the Westinghouse Electric Corporation, has been examined. The committee is assured that such an affiliation would be welcomed and that no responsibility or obligations other than those desired by the Academy would be assumed. The Academy would have made available to it the results of the ratings of local area contestants in the national competition for use in the selection of recipients of Academy recognition and encouragement.

The Academy now participates in the annual Washington Science Fair which encompasses the entire high school population of the area. Expanded participation in the Science Fair would provide more opportunity to recognize and encourage science talent in the early high school years.

It is the opinion of the committee that the problems of recognition of science talent in the Washington area can be solved by affiliation with the National Science Talent Search and expanded participation in the Washington Science Fair.

Encouragement of science talent once recognized may take many forms. The committee believes that, in any case, its principal objective should be to foster, guide and support the development of scientific talent to a point from which the individual with the talent can continue "on his own steam".

Encouragement may be physical, in the sense of providing ways and means for further training or education in scientific disciplines; such as, awards of scholarships, fellowships or other financial subsidies, or provision of opportunities to work in research institutions. It may be mental, in the sense of providing intellectual stimulation; for example, by providing opportunities for association in an intimate manner with competent, mature scientists in various fields. Lastly, it may be psychological, in the sense of influencing development indirectly; for example, by the award of certificates or minor honors to set apart individuals on a basis of achievement. Obviously these forms may, and probably should, be combined. The committee believes the association of minds to be the most desirable fostering method. It recognizes the idealistic aspect of that point of view, although the method has been employed frequently, particularly when exceptionally talented young people have spontaneously made their own contacts. The factor of spontaneity is of utmost importance to the method's success, since the contact is likely to fail of achievement if the student or matured scientist feels a loss of independence. Recognition of the human aspects of the problem appears to lead to the necessity of including other forms of encouragement. In this connection it is the opinion of the committee that the use of financial rewards should be considered as the least desirable form of encouragement.

Consideration also has been given to the recent report of a Special Committee on a Junior Washington Academy of Sciences, published in the JOURNAL **38**:(6): 220–222, June 15, 1948, which outlines the value of a Junior Academy in the encouragement of science talent as well as the functions of such a group. It is the opinion of the committee that a Junior Academy, governed by a small committee of senior Academy members, would provide an eminently suited mechanism for encouraging young science talent in consonance with the principles discussed above.

The question of Academy awards for achievement has been considered in conjunction with participation in the National Science Talent Search. If the Academy is to participate in the Search it must be prepared to recognize outstanding local talent in some material fashion. The committee believes that public award of a certificate of merit at a meeting of the Academy would constitute suitable recognition, and would be consonant with the resources of the Academy.

The committee therefore recommends:

1. Affiliation with the National Science Talent Search as a local sponsor, at the earliest practicable moment; and public award of Certificates of Merit to selected outstanding local participants in the National Science Talent Search.
2. That the Academy consider the possibility of expanded participation in the Washington Science Fair.
3. Formulation of a detailed plan for a Washington Junior Academy of Sciences, including a constitution, bylaws, and budget.
4. Appointment of a Standing Committee on Encouragement of Science Talent to implement the above recommendations; this committee to consist of six members, of which two are to be appointed annually for three year terms.

MARTIN A. MASON, *Chairman.*
A. T. MCPHERSON
B. D. VANEVERA
FRANK THONE

The Board of Managers accepted the report of the above committee and referred the matter of creating a Standing Committee on Encouragement of Science Talent to the Committee on Bylaws for definition and phrasing preparatory to its incorporation into the Standing Rules.

The chairman of the Committee on the Index to the JOURNAL, Dr. W. N. FENTON, presented an informal progress report. He informed the Board that the matter of indexing had been taken up with Miss MARY A. BRADLEY, Technical Editor, Bureau of Entomology and Plant Quarantine, who agreed to index a sample volume of the JOURNAL for the purpose of establishing standards and determining costs, reporting her findings to Dr. FENTON and Mr. OEHSER.

L. L. HARTER was transferred to the retired list of members as of December 31, 1944.

The Secretary announced the death of LOUIS COHEN, of Arlington, Va., on September 28, 1948; and of H. T. HERRICK, formerly of the Bureau of Chemistry and Soils, on October 7, 1948.

The Academy's representative on the council of the American Association for the Advancement of Science, Dr. FRANK THONE, gave an informal report on the Centennial Meeting of the A. A. A. S., which took place in Washington during the middle week of September. He pointed out that he had secured the nomination of Dr. CONDON, an Academy member and Director of the Bureau of Standards, for presidency of the A. A. A. S. for 1949. He also called attention to a meeting of the State academies of science and a paper which he presented on Federal aid to science. It was announced that the 1949 annual meeting would be held in New York during the Christmas week.

The meeting was adjourned at 9:10 P.M.

C. LEWIS GAZIN, *Secretary.*

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MATHEMATICS.—*A fallacy regarding integers.*[1] N. ERNEST DORSEY.

In various places [*1–7*], including this JOURNAL, one finds statements, intended for those who do not pretend to be expert mathematicians, to the effect that in a full sequence of integers the number of the even integers (2, 4, 6, 8, . . .) is as great as that of all integers (1, 2, 3, 4, 5, . . .), odd as well as even. To us nonmathematicians that statement is manifestly absurd if it refers to the sequence of integers with which we are acquainted. With reference to that sequence, and there is nothing to indicate that reference is made to any other, it is certainly false. In none of those citations is there any suggestion that the statement does not mean what a nonmathematician should be expected to think that it means; and there is no indication that it involves any postulate with which we are not acquainted. Furthermore, none of them presents satisfactory evidence of its truth.

Consequently, I have tried to find out what it is all about, examining various sources in addition to those cited and conferring and corresponding with several, mathematicians and others, mainly for the purpose of eliciting information. To all who have assisted me, I am most grateful.

In order that all may know of what I write, it seems well to recall the actual structure of our sequence of integers, to make certain remarks concerning it, and to define what we mean when we say that the ratio of the number of the b's to the number of the a's and b's taken together is equal to r.

Our sequence of integers is the sequence of ideas used in counting, say in counting sheep going in a certain direction through a gap in a fence. The ideas involved run thus: a sheep, another sheep, another, another, another, and so on, potentially without end. They may be symbolized thus: 1 sheep, 2 sheep, 3 sheep, and so on. Since one may count anything in the same manner, one obtains the symbols of the bare integers: 1, 2, 3, 4, . . . , $n - 1$, n, $n + 1$, . . . These bare integers, however, are always understood to refer to some definite, though unspecified, unit (e.g., a sheep) which remains unchanged throughout the sequence. Furthermore, each symbol may conveniently be, and is, used to denote the number of those units that have been counted from the beginning up to and including itself, each symbol standing for the idea of a multitude of permanent, noninteracting, and well-defined units, either actual or in one's mind.

This sequence of integers is a mental construct existing in its own right. It is strictly autonomous. It may be completely defined as follows: It has a first term, which is the idea of a particular, definite unit-of-count (u_c); this term is followed by an unbroken sequence of other terms, each term corresponding to the idea of a multitude that is a single u_c greater than that corresponding to the preceding term; there is no final term. The sequence is truly endless. Nevertheless, no term in it, no matter how far along the sequence one may go, has any valid right to any property that is not conferred by the definition—in every case, adding a single u_c to the multitude converts it to the multitude that corresponds to the next higher term of the sequence; and conversely. Every one of the multitudes is built up unit by unit and may be similarly torn down. If one desires to describe the early terms (1, 2, 3, 4, . . .) of the sequence by the adjective "finite," then that same adjective is an equally valid description of each and every term of the sequence. That the mere multiplicity itself confers no special property upon the multitude is at once evident from the fact that a

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[1] Received November 24, 1948.

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given quantity of a homogeneous substance that may be subdivided indefinitely may, by a suitable choice of the unit of measure, be expressed as a multitude (of those units) of any multiplicity that may be desired; and that may be done by a mere mental choice of units, without any change in the actual division of the quantity. Certainly, no actual change in any property is involved in such a purely arbitrary change in the multiplicity. Hence, any change that may occur as a result of an addition of units to a multitude depends upon the properties of the substance of the quantity concerned and not upon the mere multiplicity itself. The properties pertaining to the integers themselves undergo no progressive change of any kind as one passes along the sequence of integers, and no peculiar sudden change at any point far along in the sequence.

By definition, the alternate terms (1, 3, 5, 7, . . .) in the sequence, beginning with the first, are called "odd integers"; the intermeshing alternate terms (2, 4, 6, 8, . . .), beginning with the second, are called "even integers."

There are actually as many distinct sequences of integers as there are kinds of things, and of groups of things, and of parts of things, that one may imagine that he wishes to count or to assemble into multitudes of various multiplicities. The number of such distinct sequences is limited solely by one's power of imagination; but each of them is built according to the same plan—that fixed by the definition already given—and is potentially endless.

No two of those sequences are in any way related, except it be through an interrelation between their respective units-of-count; and it is obvious that there are many ways in which two such units may be interrelated. Thus arise systems of sequences, the number of sequences contained in a system depending upon the particular nature of the interrelation of the units.

An important type of system of sequences, and the only one that need now be considered, is that in which all the sequences refer to the same substance, but differ among themselves in the magnitude of the unit-of-count. If the substance is such that it can be thought of as capable of being subdivided without limit, then the system contains potentially a limitless number of sequences. There is such a distinct limitless system for each and every substance that can be so divided. Obviously, all systems that are of exactly the same type can be represented by a single "absolute" system, in the same sense that sequences of integers may be represented by an "absolute" sequence.

The seven central sequences of one such system are shown in Table 1. That system consists of sequences for which the several units-of-count are the integral multiples and submultiples of a basic unit u. The sequence (S) for that basic unit is regarded as the central sequence of the system. Symbols lying in the same vertical column of the table correspond to equal quantities of the substance. Stars serve to mark the absence of terms in the sequence concerned.

Obviously, the quantity (Q) of the substance corresponding to N units, each of quantity q, is given by the equation $Q = Nq$, it being assumed that Q and q are each expressed in terms of the same unit of measure. Consequently, the number of terms in the sequence corresponding to Q is $N = Q/q$; and that is true however great Q may be. The N so defined is the actual number of terms in that sequence.

If Q increases without limit, so does N, since q is constant throughout any one sequence. On the other hand, if Q remains constant and q is progressively decreased by passing from sequence to sequence, then N increases indefinitely as q decreases indefinitely.

Since N is twice as great when the unit-of-count is $u/2$ as it is when the unit is u (see sequences A$''$ and S of Table 1), and since the number of even integers in a full sequence is half as great as the number of both odd and even integers, it is obvious that the number of even integers in the long sequence A$''$ is the same as the number of all integers (odd as well as even) contained in the short sequence S, the quantity of the substance being the same in each. That is true, no matter how great may be the quantity Q. Evidently, the significance of a given integer-symbol depends upon the particular sequence to which it belongs. In the seven sequences shown in the table, the quantity represented

Table 1.—Seven Central Sequences of a System

u_c	Sequence	
$u/4$	0**1**2**3**4**5**6**7**8**9**10**11**12**13 **14* *15**16 . . .	A''''
$u/3$	0***1***2***3***4***5***6***7* **8 *** 9** *10* **11 ***12 . . .	A'''
$u/2$	0*****1*****2*****3*****4***** 5** *** 6** * ** 7* * *** 8 . . .	A''
u	0***********1***********2***** *** *** 3** * ** ** * *** 4 . . .	S
$2u$	0***********************1***** *** *** *** * ** ** * *** 2 . . .	B''
$3u$	0***************************** *** *** 1** * ** ** * *** * . . .	B'''
$4u$	0***************************** *** *** *** * ** ** * *** 1 . . .	B''''

by a given symbol varies over a range of 1 to 16. That the significance of an integer-symbol depends upon the unit to which it refers is merely what one learned in primary school when he was introduced to denominate numbers. So long as the unit-of-count remains unchanged, it need not be mentioned, but any change in that unit changes the significance of the integer-symbols, and that change cannot be ignored without introducing an error into one's manipulation of the symbols.

What does one mean when he says that the ratio of the number of b's to the number of a's and b's taken together is r?

By that statement, the nonmathematician means as follows:

(1) The a's and the b's are each to be chosen from a fully specified multitude, which may, but need not, consist of two or more submultitudes.

(2) Every a and every b in that multitude is to be counted, and counted but once.

(3) No a and no b is to be taken from any other multitude.

(4) The ratio of the number, as so determined, of the b's to that of the a's and b's combined is r.

This completes the definition of r when the multitude is one having a determinate number of elements.

If, however, the multitude is not determinate, but is composed of an unending sequence of elements, then it is necessary to specify the manner in which the preceding definition is to be extended so as to cover the sequence as a whole.

For present purposes, only a single type of such multitudes need be considered; viz., that in which the a's and b's are terms in a regular sequence proceeding according to a fixed and known law, serving to relate the several neighboring a's and b's to one another in a definite manner, the same throughout the entire sequence.

In such a case, we nonmathematicians proceed as follows: The early terms of the sequence, extending from its beginning to and including some particular term n, is a determinate multitude. For that multitude we determine r in the manner just described. Then we study the way in which r varies with n, such variation being unambiguously fixed by the known law connecting the terms. If r be found to be independent of the particular value of n that has been chosen, then we say that the value of r found in this manner is the value for the sequence as a whole. If however, as n is increased by steps from n to $(n + 1)$ to $(n + 2)$ to $(n + 3)$, etc., it be found that r oscillates from r to $(r\text{-}e')$ to r to $(r\text{-}e'')$ to r, etc., oscillating always between r and a value $(r\text{-}e)$ in which e is a positive number that never exceeds unity and that steadily decreases as n increases, the decrease being of such a kind that it is possible to determine a number v such that e shall be smaller than any predetermined small number for every value of n that is greater than v, then we say that r is the value of the ratio for the sequence as a whole.

From the very definition of the sequence of integers, it is obvious that for every even value of n the ratio of the number of even integers to the number of all integers (odd as well as even) is exactly one-half; and for every odd value of n that ratio is $(1 - 1/n)/2$ That is, the ratio oscillates between $1/2$ and $(1 - 1/n)/2$. Here, $1/2n$ corresponds to e, and fulfills the specified condition, decreasing indefinitely as n is increased. Hence, we nonmathematicians say that in a full sequence of integers the ratio of the number of even integers to that of all integers (odd as well as even) is one-half.

It may be well to remark that this procedure is not in the least related to the thoroughly illegitimate one of attempting to extrapolate from numerous special instances that are not so related as to justify the extrapolation. In the present case, the several particular instances are definitely related to one another by the definition of the sequence. That relation applies throughout the sequence, and leads to a definite conclusion.[2]

Such is the way we nonmathematicians attack the problem, and such is our conclusion. The procedure seems to be thoroughly sound. We can not, and will not, renounce that conclusion on the mere *ipse dixit* of anyone.

Turn now to a consideration of what has been offered us in justification of the statement to which exception was taken at the beginning of this article; viz., that in a full sequence of integers the number of even integers is just as great as is the number of all the integers (odd as well as even).

In each of the seven citations, the "proof" of the contested statement is based upon the pairing of the symbols in the manner shown in (1), the terms in (B), the sequence of

$$\begin{array}{llllllll} 1 & 2 & 3 & 4 & \ldots & n & \ldots & (A) \\ 2 & 4 & 6 & 8 & \ldots & 2n & \ldots & (B) \end{array} \qquad (1)$$

symbols for the even integers, being paired, one by one, with the successive terms of (A), the sequence of symbols for all the integers, odd as well as even. The mere possibility of setting up such pairing for a few terms seems to be regarded as proof that it is valid for the sequence as a whole.

Obviously, it is not. No one will question the fact that, in virtue of the potential endlessness of the sequence of integers, one can, by going sufficiently beyond any specified term n of that sequence, find as many even integers as he may desire, and in particular the n of them that are required for the pairing shown in (1). But that is not the whole story. The pairing shown in (1) represents a small number of particular cases: (1/2), (1, 2)/(2, 4), (1, 2, 3)/(2, 4, 6), etc. In order that one may be justified in extrapolating from them to the sequence as a whole, those several particular cases must have each been taken from a "fair sample" of the portion of the sequence to which it refers, and *every item* in such sample must have been used in the proper manner in setting up its particular case. That requirement has not been met.

A fair sample being such a sample that its drawing from the sequence leaves the remainder of the sequence totally unaltered, it is obvious that the terms forming the fair samples from which the three particular cases just mentioned were constructed are these: 1, 2; 1, 2, 3, 4; 1, 2, 3, 4, 5, 6. For these samples, the ratios of the all to the evens are, respectively, (1, 2)/2; (1, 2, 3, 4)/(2, 4); (1, 2, 3, 4, 5, 6)/(2, 4, 6). In each case, the number of all is twice as great as the number of the evens. And that remains true however far one goes along the sequence. Hence the evens are only half as numerous as all. Any attempted justification of the contested statement from the pairing shown in (1) rests upon the thoroughly invalid procedure of attempting to extrapolate from unsuitable particulars.

And one may ask: Why not pair the terms in the obviously valid manner shown in (2), pairing each term of (B) with its identical

$$\begin{array}{lllllllllll} 1 & 2 & 3 & 4 & 5 & 6 & \ldots & (2n-1) & 2n & (2n\ 1) & \ldots & (A) \\ & 2 & & 4 & & 6 & \ldots & & 2n & & \ldots & (B) \end{array} \qquad (2)$$

term in (A)? Every term of (B) is then paired with a term of (A), but there are no remaining even integers to pair with any of the odd integers in (A). There neither is nor can be any reciprocal one-to-one correspondence set up between the terms of (A) and those of (B). Obviously, a mere shifting of the (B) terms to the left, so as to place the "2" under the "1" and to close the gaps, does not in the least either change the number of the terms or establish the possibility of such correspondence. The type of pairing shown in (2) is completely ignored in all seven of the citations.

Furthermore, a mere inspection of (1) shows that in the first $2n$ terms of the full sequence of integers there are only n even terms, no matter how great n may be. This also is not considered in any of the citations. But in conference, this objection has led to the remark that the objection holds good only so long as n is finite; for the endless—the infinite—sequence it fails, since half of infinity is infinity. That is not a satisfactory answer, for two reasons. *First*, every term in the endless sequence is as truly finite as are the early terms, as previously remarked. Consequently, "infinity" finds no proper place in any discussion of the problem, other than as a short word for the vague expression "exceedingly great." *Second*, early in one's study of differential calculus he is introduced to "*indeterminate quantities*" and is taught how to evaluate them. He then learned that if n is infinite $2n/n$ is equal to 2; although numerator and denominator are each infinite.

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[2] A simple mechanical analogue of the sequence of integers is a two-bladed electric fan, one blade being red and the other blue. As the fan spins, the succession of the colors passing a fixed point on the circumference of the circle traced by the tips of the blades is exactly that of the succession of odd and even integers as one passes along a sequence of integers.

Others have countered with the statement that the mathematicians concerned have denied that a part of an infinite quantity is less than the whole. A positive statement seeming preferable to a negative one, I should say that they have assumed that a part of an infinite quantity is as great as the whole. No objection can be raised against one making that, or any other, assumption for the purpose of seeing to what it may lead, provided that he recognizes that it is an assumption undergoing test. But it is invalid to accept such an assumption as a basis for reasoning if it is found to be in contradiction with what is known in the field concerned, such contradiction not residing in a previously unrecognized limitation of the validity of one or of both of the conflicting conclusions. In the present case, as already shown, "infinity"—meaning anything more definite than "a very great number"—has no place in the discussion. Irrespective of that, the conclusion (said to have been drawn from the assumption) that the even integers of a sequence are just as numerous as all integers (odd as well as even), is in direct conflict with that demanded by the definition of the sequence—that the evens are only half as numerous as all. Such conflict shows that in this connection the assumption is not valid. Conclusions drawn from it in this field rest upon an unsupported assumption.

The confusion is increased by the fact that some appeal from the contested statement through (1) to justify the assumption just discussed; whereas others, as just stated, appeal from the assumption through (1) to justify the contested statement. Surely it is improper to argue in both directions.

Further confusion is caused by the occurrence, here and there, of statements implying that in (1) *only symbols* are involved; whereas one finds it stated that the sequence (B) of (1) is obtained by multiplying the several terms of (A) by two. Now, the multiplication of a mere symbol by two does not result in another symbol, but solely in two symbols of the same kind. It is only of the multitude for which the symbol stands that one can validly interpret multiplication by two as resulting in a multitude of twice the multiplicity of the original, and therefore representable by a different symbol. Those attempting to work with mere symbols are attempting to deal with multiplicity divorced from multitude; from which, however, multiplicity derives its sole meaning. They are trying to work with a seriously mutilated idea.

Notwithstanding the preceding criticisms, there is a sense in which (1) is valid for the entire sequence (A). But it is not the sense in which it is understood by the upholders of the contested statement. By reference to sequences S and A″ of Table 1, it will be seen that (1) is entirely valid if the terms of (B) are the even terms, not from sequence (A), but from the sequence for which the unit-of-count is half as great as is that for sequence (A). In fact since one may count not only by 1's but also by 2's or by 3's or by groups of any other size, one can construct such a sequence that its "1" may be equivalent to, and so may be paired with, any desired term of a standard sequence; and the same is true of its "2" or its "3" or any other of its integer-symbols. To speak of pairing the even integers with all the integers (both odd and even) is thoroughly ambiguous unless the relation between the two sets of integers —those in (A) and those in (B)—is definitely specified. Such specification is not explicitly given in any of the citations, but the implication is that the two sets are from the same sequence. Hence, in this article I have plainly inserted that implied specification.

The truly surprising situation revealed by this study—the failure of each justification that has been offered, and the complete ignoring of obvious evidence of the falsity of the contested statement—demands an explanation. That must be sought in the history of the development of the dogmas that are today accepted by those who uphold the contested statement. However, circumstantial evidence that points to a plausible explanation is readily available.

B. Bolzano (1781–1848), called by the late Cassius J. Keyser, of Columbia University, a "mathematician, philosopher, and theologian," published a volume on the paradoxes of the infinite (Paradoxien des Unendlichen), which Keyser described as "a pioneer work in the mathematical doctrine of infinity" [*2*, p. 158]. The appearance of such a book indicates that "paradoxes" relating to infinity were of current interest, and that the word "infinite" or "infinity" was accepted as indicating some vague, ill-defined notion that was compatible with conclusions that violated our ordinary experiences. It is difficult to escape the conclusion that that notion was of metaphysical origin, and that the word was steeped in metaphysical mysticism. That word, taken over in the development of the mathematical doctrine of infinity, inevitably carried with it not a little of its mysticism, thereby conditioning mathematicians to a ready acceptance of conclusions that would otherwise have been subjected to the closest scrutiny.

In that volume Bolzano gives a proof, accepted by Keyser at least as late as 1922, that the infinite number of points composing a line-segment may be put in a one-to-one correspondence (i.e., may be paired) with a half of themselves. As given by Keyser, the proof is essentially as follows: Let the segment extend from 0 to 1; let x denote the distance from the point at 0 to another point on the segment; let y denote the distance from 0 to the point with which the point at x is to be paired; and let $y = \frac{1}{2}x$ be the law of pairing. Then, by construction, the point at 0 is paired with itself; that at 1 is paired with the point at $\frac{1}{2}$; and the points between 0 and 1, with those between 0 and $\frac{1}{2}$. Hence the points between 0 and 1 have been placed in a mutual one-to-one correspondence with a half of themselves.

Evidently nothing of the kind is possible for any finite multitude, for any multitude with which we have any firsthand information. Its possibility in this case is to be attributed to the multitude's being infinite. Just how that can be so, no one knows; it arises in some unexplained way from the (unmentioned) mysticism that is attached to the words "infinity" and "infinite."

If such a relation is a characteristic of the notion covered by those words, then it must be valid for the sequence of integers, since that is endless, "infinite." All that remains is to conjure up some device that will reveal it. One short step, and one has the contested statement.

However, doubts arise when one considers critically the proof (?) just given. Leaving aside every question of the construction of a line from points—of the creation of extension from non-extension—, it is evident that one point can be distinguished from another only by being separated from it by an element of length. And it is equally evident that it is utter nonsense to speak of putting into a one-to-one correspondence points that are not individually distinguishable. The assumed law of pairing demands that the first x-point beyond that at 0 shall be paired with the point midway between those points—at a place where there is *no* x-point—; the second x-point beyond 0, with the first x-point (it being assumed[3] that the x-points are equidistant, each from the next); the third, midway between the first and the second—where there is *no* x-point—; and so on. The x-points have been paired with an equal number of points, some of which are x-points and others of which are not. The x-points have *not* been put in a one-to-one correspondence with a half of themselves. The situation becomes clearer if the law of pairing is put in the differential form: $dy = \frac{1}{2}dx$. Each element dx of the segment has been paired with another only half as long. The same number of elements is in each group. There is nothing paradoxical involved.

Does some one object that this criticism is irrelevant, since it refers to a finite number of elements? If so, he should recall that

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[3] So assumed merely for simplicity. Any other distribution would result in a pairing of still more x-points with places where there are no x-points.

although the number of elements making up a line-segment may be as great as one pleases (and in that sense the number is infinite), the actual number in any specific case is *always* a determinate one, and therefore finite—it is always equal to L/dl, where L is the length of the segment, and dl is the common length of the several elements into which the segment is supposed to be divided. Otherwise than as an indication of the acceptance of the doctrine of the unlimited divisibility of extension, the words "infinity" and "infinite" have no proper place in the discussion.

Since the sequence of integers, regarded as beginning with 0, may be exactly represented geometrically as equidistant points lying along a line, the same remarks apply to it.

The misconception of the problem and of its solution seems probably to have arisen from mysticism and a failure to recognize the distinction between two quite different characteristics of a multitude; viz., magnitude and multiplicity—a failure that seems to have persisted to today.

A multitude is a single complex idea, and should be considered as a whole. In order to specify it exactly, one must specify its nature (e.g., linear extension), its magnitude (e.g., the length of the line-segment), its multiplicity (e.g., the number of elements contained in it), and it should be made plain whether the magnitude of any element is affected by its mere association with the other elements, and if so, in what manner. Assume that the magnitude of an element is unaffected by the presence of other elements, and that all elements are of the same magnitude m (e.g., dl). Write M for the magnitude of the multitude (e.g., L, the length of the line-segment), and N for the multiplicity, the number of the elements. Then, $M = Nm$ or $L = Ndl$, provided that the unit of measure of magnitude is the same for each term of either equation. Whence, $\frac{1}{2}L = \frac{1}{2}(Ndl) = (\frac{1}{2}N)dl = N(\frac{1}{2}dl)$. If the half-magnitude is made up of $\frac{1}{2}N$ elements, each of length dl, then the N elements of the whole multitude *cannot* be placed in a one-to-one correspondence with the $\frac{1}{2}N$ elements of the half-magnitude. But if the half-magnitude is made up of N elements, each of length $\frac{1}{2}dl$, such correspondence is possible. This is illustrated by sequences (3), (4), and (5). The terms of sequences (3) and (4) are each composed of two equal parts. Evidently, (4) and (5) are each equal to half of (3), but (3) cannot be put in a one-to-one correspondence with (4), although it can with (5).

Bolzano and Keyser each thought that he was dealing with the case represented by (4), whereas the proof had to do with the equivalent of (5). Had they not been mentally overwhelmed by the mysticism attaching to the words "infinity" and "infinite," they would surely have examined the proof (?) critically, and I doubt not that each would have discovered the error in his understanding of it.

It seems probable that the contested statement arose in some such way, and that its persistence is to be attributed to two main facts: (1) The perennial attraction of mysticism, and (2) a failure to appreciate the great wealth of sequences of integers and the vast systems of related sequences.

That the first has persisted even to today is shown by the importance that is attached by many to paradoxes and to the construction of them. This is especially surprising when one recalls that the generally recognized object of science has always been to bring order into our experiences, to eliminate confusion.

The failure noted under (2) perhaps arose from intemperate abstraction—from such abstraction as seriously mutilated the fundamental idea underlying the integers. When and by what process it arose must be left to historians to decide.

Three more remarks are perhaps in order:

(a) Nothing that I have said is to be considered as a condemnation of metaphysical speculation or of the mysticism that necessarily attends it, but the introduction of such mysticism into what is supposed to be a discussion of a problem in an exact science is, to say the least, anomalous. It is contrary to the basic purpose of science.

$$[(A, A)_1\ (A, A)_2\ (A, A)_3\ \ldots\ (A, A)_n\ (A, A)_{n+1}\ \ldots\ (A, A)_{2n-1}\ (A, A)_{2n}] \tag{3}$$

$$[(A, A)_1\ (A, A)_2\ (A, A)_3\ \ldots\ (A, A)_n] \tag{4}$$

$$[\ A_1\quad A_2\quad A_3\quad \ldots\quad A_n\quad A_{n+1}\quad \ldots\quad A_{2n-1}\quad A_{2n}] \tag{5}$$

(b) One seeking the origin and justification of the contested statement encounters references to Cantor and his "transfinite numbers." I have yet to see what those numbers, entirely external to our sequence of integers, have to do with the distribution of integers in that sequence. But the occurrence of such references raises a question as to whether Cantor appreciated the wealth of such sequences and the existence of systems of related sequences. If he did not, that failure may have affected the validity of certain of the conclusions drawn by him and his disciples.

(c) Since one can have no immediate knowledge of the properties of an endless sequence as a whole, all knowledge of such properties must be derived in one or another of three distinct ways. It may be derived (1) by a logical extrapolation from one's knowledge of limited sequences, or (2) from certain gratuitous assumptions regarding endless sequences, or (3) from direct revelation received by some one. The last is of no evidential value to another. To others, it is indistinguishable from (2) and must be justified in the same way as that. Such justification must rest upon the congruence of the logical consequences of the assumption with what one knows of corresponding limited sequences. If instead of congruence there is direct conflict, then the assumption, or supposed revelation, must be regarded as invalid. Otherwise, one must renounce the long-accepted object of all science—the attempt to order our experiences in a logical manner. In the present case, a definite conclusion can be reached in the first way, and is, of course, congruent with our experience. If the contested statement is not merely the result of faulty reasoning, it necessarily involves either (2) or (3); and being in conflict with our experience, one must conclude that such underlying assumption is invalid in this connection.

There is, however, another approach: that relating the properties of such sequences to the nature and condition of whatever it is that is being counted and assembled. The study of properties resulting from the nature and condition of what is being counted, and changing with them, does not fall in the province of mathematics, but in that of other sciences, of philosophy, or of metaphysical speculations.

To conclude: the contested statement is indubitably false if it means what it seems to imply and what a nonmathematician should be expected to think that it means. If it means something else, then those writing for nonmathematicians are under obligation to state plainly what they do mean by it.

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ENTOMOLOGY.—*Distributional and synonymic notes on psocids common to Europe and North America, with remarks on the distribution of Holarctic insects (Corrodentia).*[1] Ashley B. Gurney, U. S. Bureau of Entomology and Plant Quarantine.

Psocids comprise a fascinating group of small insects found in all the principal regions of the world, but, with the exception of a few cosmopolitan species that are associated with man and are commonly called booklice, they are not well known even to most entomologists. The notes gathered in this paper are designed to contribute to the much-needed comparative study of the Nearctic and Palearctic psocid faunas. Here I have sought to explain which species occur in both faunas and whether they live under natural conditions or primarily in association with man. I have clarified their taxonomic status where possible. The accompanying notes on the Holarctic distribution exhibited

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[1] Received September 28, 1948.

in certain other insect orders, and on the methods of dispersal presumably responsible for the Holarctic character of many species, are intended to show how psocids compare with other insects with respect to distribution.[2] The distributional and synonymic notes are grouped mainly at the end of the paper so as not to inconvenience readers primarily interested in the broader problems of distribution.

At present 18 species of psocids are known to occur both in Europe and in America north of Mexico. This constitutes approximately 14 percent of the described Nearctic psocid fauna, though slightly less than half of the 18 species are believed to have a natural Holarctic distribution. Other species will probably prove to be Holarctic, though the discovery of undescribed Nearctic species may prevent the above percentage from changing materially.

Species common to Europe and North America.—Psocids now recorded from Europe and North America include 9 cosmopolitan species largely associated with man—*Psyllipsocus ramburii* Selys, *Dorypteryx pallida* Aaron. *Liposcelis divinatorius* (Müller), *Trogium pulsatorium* (Linnaeus), *Lepinotus inquilinus* Heyden, *L. reticulatus* Enderlein, *L. patruelis* Pearman, and *Myopsocnema annulata* (Hagen).

There are 8 so-called wild species in both regions, living mainly outside of human habitations—*Graphopsocus cruciatus* (Linnaeus), *Psocus bifasciatus* Latreille, *Philotarsus flaviceps* (Stephens), *Mesopsocus unipunctatus* (Müller), *M. laticeps* (Kolbe), *Pteroxanium kelloggi* (Ribaga), *Cerobasis guestfalica* (Kolbe), and *Liposcelis bicolor* (Banks).

One cosmopolitan species is abundant in both natural and domestic situations, *Lachesilla pedicularia* (Linnaeus).

A study of the Arctic fauna often reveals species that occur in both Europe and America. Arctic psocids have been poorly collected, particularly in North America, but Arndt (1931) has reviewed those of Europe. Of 17 species treated by him, 5 (29 percent) are found on both continents, though he does not so record all of them. In addition, he indicates that *Trichadenotecnum sexpunctatum* (Linnaeus)occurs in both Europe and North America. The American record of this well-known European species originated with Aaron (1883), who reported it under the name *Psocus sexpunctatus* from near Philadelphia. Aaron's record was repeated by Enderlein (1909), who also reported two nymphs from Jalapa, Mexico. Chapman (1930) does not refer to *sexpunctatus*, and the two records probably were based on *T. slossonae* (Banks) or related Nearctic species. The most recent paper dealing with Nearctic species of *Trichadenotecnum* is by Sommerman (1948), and it is clear that there are enough superficially similar Nearctic species to render untrustworthy the American records of *sexpunctatus*, certainly those based on nymphs.

Affinities of Nearctic psocid fauna.—The majority of the genera in North America occur in Europe also, though the exact percentage cannot be given until a generic revision of North American psocids permits the faunas of both continents to be classified according to a comparable system. Outstanding genera known in North America, but not in Europe, include *Polypsocus*, *Myrmicodipnella*, *Speleketor*, *Archipsocus*, *Deipnopsocus*, and *Echmepteryx*. Species of the three last-named genera, together with all American species of *Psyllipsocus* except *P. ramburii*, represent the northern fringe of considerable Neotropical fauna in these genera. The latter species has been so carried in commerce that its origin is uncertain. Banks (1915) noted that *Polypsocus* is a peculiar development in America. *Speleketor*, represented only by the cave-inhabiting *S. flocki* Gurney (1943) of Arizona, is apparently a relic from an ancient fauna, and the related but distinct *Prionoglaris* of European caves is an Old World representative of the same group of genera. Thus, most Nearctic psocids have their closest affinities with the European fauna, while a minority are derived from Neotropical stock. A few specialized types are peculiar to North America. In the absence of comprehensive work on Siberian psocids, the full extent to which the group is Holarctic remains in doubt, but enough is known of the faunas of North America, Europe, and Japan to suggest the existence of important Holarctic elements.

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[2] Dr. Kathryn M. Sommerman has generously lent material from her valuable collection of psocids, and I am also much indebted to her for helpful suggestions. Several of my colleagues have kindly advised me on distributional matters in orders other than the Corrodentia, and Orthoptera, and each is mentioned at the appropriate place.

While considering the subject of Holarctic psocids, it is instructive for purposes of comparison to observe the situation in several other insect orders. One of the first serious attempts to document insects common to the Nearctic and Palearctic regions is Hamilton's (1889) study of the Coleoptera. He listed 484 species then believed to occur in both regions and estimated that the distribution was natural for 278 (57 percent) and either the result of artificial introductions or of a doubtful origin in the remaining 206.

Broad generalizations based on Hamilton's list, such as the dependence placed on it by Scharff (1899, *p. 161*) in attempting to support a view favoring migrations over an American-European land bridge, are conditioned by subsequent studies which show many of Hamilton's species to have, in fact, a different status[3]. Introductions by man are rapidly increasing, but even in Hamilton's time were probably more numerous than he supposed. Some of the species concerned are in genera which require thorough revision before any sound statements may be made regarding intercontinental distribution. Modern studies of genitalia or other taxonomic refinements show certain "species" of older workers to be composite. Other species presumably have a common origin, though distinct subspecies may now represent them on the two great land masses. Although there are true Holarctic beetles, particularly among forms which are adapted to natural aerial transportation, or among the species associated with circumboreal vertebrates, conservative coleopterists are inclined to estimate the percentage to be very small.

Horváth (1908) discussed the extent to which Hemiptera are common to Europe and North America, and listed 261 genera and 161 species as occurring in both continents. He believed the distribution of 33 species to be the result of artificial introductions, and the other 128 to have been introduced naturally (69 Homoptera, 59 Heteroptera). It was concluded that most of the Hemiptera present on both continents originally were Palearctic, and that migration had been mainly by way of the Bering Strait.

Paul W. Oman has advised me that the portion of Horváth's list dealing with Homoptera is subject to considerable change, the number of Holarctic species being smaller than Horváth believed. In the Cicadellidae, for instance, Dr. Oman estimates that of approximately 2,200 Nearctic species only about 25 (slightly more than 1 percent) should be considered truly Holarctic. The 25 species indicated are distinctly northern in distribution and, almost without exception, feed on grasses and sedges.

In the Heteroptera, on the other hand, either many species have had a distributional background different from Homoptera, or leading students who have influenced the trend of recent taxonomic work have treated the problem of distribution in a different manner. In the opinion of R. I. Sailer comparatively few changes in Horváth's Heteroptera list are necessary in the light of recent studies. The few species in that list now not considered to be Holarctic are offset by additional examples.

In a group of Diptera whose immature stages are primarily aquatic, Townes (1945) treated 201 species of Nearctic Tendipedini, of which he considered 33 (16 percent) to occur also in the Palearctic region. Most of the Holarctic species were decidedly northern.

The Orthoptera include some 1,200 described Nearctic species, of which less than a half dozen boreal species are Holarctic. Outside of certain cosmopolitan species, mainly Blattidae introduced by man, the Nearctic and Palearctic faunas are essentially distinct as far as species are concerned. The great majority of the Nearctic and Palearctic genera are also distinct. The origin of the orthopterous lines of development are more ancient than those of most orders. The Orthoptera certainly contain fewer Holarctic elements than the Corrodentia, in both genera and species. Some discount should be made, however, because orthopterists have studied the genera of the two faunas rather independently. Particularly in America, there has been a tendency to propose a large number of genera which include one or very few species. The human factor can never be entirely overlooked when groups are compared in which taxonomic practices reflect the varying tendencies of individual workers.

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[3] H. S. Barber has recent evidence that contradicts the identities of several species listed by Hamilton, and my comments on Hamilton's list are based on Mr. Barber's impressions of Hamilton's results.

Although only rough generalizations are justified, it is evident that in nearly all orders of insects at least a few species have a natural Holarctic distribution. Rarely do more than 15 percent of the North American species of any particular major group also occur naturally in the Palearctic region. Considering North American insects as a whole, probably not more than 5 percent are also European, excluding artificial introductions.

Explanations of Holarctic distribution.—Attempted explanations of the means by which Holarctic insects have attained an intercontinental distribution have been filled with speculation, which in many cases was based on little or no evidence. I believe it is likely that air currents have been instrumental in transporting some species of Holarctic psocids, and I shall review published work which points to the reasonableness of this view. Genera often represent more ancient migrations, even though species peculiar to one continent have since developed, and they may logically date back to early geologic periods when land connections existed.

The "ballast theory."—It is important not to overlook early historic events that may have effected artificial introductions. A case in point is the "ballast theory," which probably explains the presence of many European plants and insects in the northeastern United States and the Maritime Provinces of Canada. More than 100 years ago much lumber was carried from eastern Canada to Europe, and the ships coming for such cargoes often carried a ballast of rock, sand, or soil which was used to improve the loading quays. It was first shown by botanists that many plants were brought to America in that manner, and Brown (1940) has recently offered this theory as the probable explanation for the occurrence on this continent of various European Coleoptera associated with soil. In view of the large number of psocids associated with trees, some psocids may have been transported in the shipment of lumber. Ballast still serves as a medium in which living insects are transported, though precautions are taken, at least in the United States, to prevent introductions. I recently examined a specimen of an earwig, *Forficula auricularia* Linnaeus, which was found alive at Mobile, Ala., on July 7, 1948, in grass and weed roots contained in the soil ballast of a cargo steamship from Scotland. The interception of insects in ballast is not uncommon at present, particularly in ships from northern Europe.

Fristrup's analysis (1942b) of the Trichoptera of Iceland shows that all of the 10 species occur in Europe, but only two in North America. From their distribution and from the fact that they are not the species assumed to be the most likely to be picked up by winds, he reasons that chance introductions by man primarily explain the presence in Iceland of this "random selection of the North European fauna." The early Norsemen carried water, food, and plant materials, and Fristrup suggests them as more likely agents of introduction than natural causes.

Land connections.—Of the land connections that have been postulated between the Nearctic and Palearctic regions, that at the Bering Strait is the most likely. As regards the influence of that land bridge on psocid distribution, collections from Siberia and Alaska will shed much light on its probable importance. Jeannel (1942, p. 457) believes that North America remained in direct connection with northwestern Europe until a very recent epoch of geological time and that elements from the ancient continent of Angara passed freely to America during the Oligocene and adjoining periods. He is an advocate of the Wegener hypothesis of continental drift. Forrest (1935) has even developed in a detailed manner the theory of a great land mass filling most of the North Atlantic Ocean during the ice age, but his views have not been widely accepted. At least some of Forrest's supporting evidence, such as certain of the faunal lists referred to by Scharff (1899), requires modification. For species to have maintained their identity since migrating over a land bridge means either that the connection must have been comparatively recent, or that the species are capable of remaining virtually unchanged since a quite early period.

Air currents.—Felt (1928) gave a good review of what was then known concerning the movement of insects in air currents, and Glick (1941) gave a brief but more recent summary. Wolfenbarger (1946) discussed the dispersal of various minute forms of life.

The outstanding work done in collecting insects from airplanes at high altitudes is that of Glick (1939), who showed that many psocids occur in the upper air currents. In extensive collections made mainly over Tallulah, La., during 1926–31, a total of 78 specimens of Corrodentia was taken, including 37 at altitudes of 1,000 feet or higher. Among the latter specimens, 9 were collected at 5,000 feet or above. The flightless species, *Trogium pulsatorium* (Linnaeus) and *Liposcelis divinatorius* (Müller), were both included, the former at 5,000 feet, the latter at 1,000 feet. The species most often collected was *Lachesilla pedicularia* (Linnaeus) of which 33 specimens were taken, 14 of them from 1,000 to 5,000 feet, one at 8,000 feet, and one at 10,000 feet. Thirty-one specimens were not identified.

Berland (1935) earlier reported collecting a specimen of *Lachesilla pedicularia* at an altitude varying from 700 to 1,000 meters over France. Since *L. pedicularia* is regularly carried in commerce, its capture at high altitudes above both continents does not necessarily imply that it is carried between the continents in air currents. It is known, of course, that myriads of psocids belonging to common species often fly near the ground surface, as demonstrated by large numbers of *L. pedicularia* and *Ectopsocus pumilis* (Banks) which I have seen stuck to a freshly painted house in Virginia. Profft (1939) trapped insects flying in German rape fields by erecting adhesive surfaces to catch them. In eight days he collected 1,708 psocids near the ground surface; their identities he did not report.[4]

Many of the insects collected by Glick (1939) at high altitudes were alive, though he did not specify whether living psocids were included. Since the psocid samples collected were but an infinitesimal portion of the insect population existing in the air above some portions of the earth, and since it is known that large stocks of psocids exist in the air near the surface, is it not logical to assume that some living individuals are safely carried long distances?

The questions naturally arise as to what air currents often move between the Neartic and Palearctic regions, and what likelihood exists that psocids or other insects have been carried by them.

The prevailing winds over the North Atlantic Ocean are westerlies, and most hurricanes in that area also go from west to east. Mitchell (1924) has discussed the paths of hurricanes, and has also shown (fig. 24), for example, that prevailing winds from New England and Newfoundland during July and August go northeasterly to the British Isles and northwestern Europe. Maps are given outlining the courses of the important North Atlantic hurricanes for the years 1887–1923. Hurricanes normally form east of the West Indies or just west of Cuba and Jamaica, then move northwesterly, some of them missing the North American Continent, others penetrating the Eastern States to a considerable distance before turning northeasterly. Many hurricanes skirt the coasts of or pass over the Northeastern States, Newfoundland, and the Maritime Provinces, then go to Greenland and Iceland, or to the British Isles, Norway, or even France. Some short, irregular hurricanes spend themselves entirely at sea. Hurricane intensity is characterized by winds moving at least 60 miles per hour. The time required for hurricanes to move from Newfoundland or New England to Iceland or northwestern Europe is usually at least four days, often more. Hess et al. (1937, p. 68) point out that more American birds are blown to the British Isles than there are European birds blown to America, and these authors attach importance to the fact that the prevailing North Atlantic winds are westerlies.

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[4] R. L. Post has recently sent me specimens of *L. pedicularia* found September 14, 1948, in very large numbers on the freshly painted side of a house at Fargo, N. Dak.

It is not definitely known that any Holarctic psocids originated in North America, but in the family Psocidae (strict sense) there are considerably more species in the United States than in western Europe. According to one school of thought, to which I do not entirely subscribe, that fact would suggest that North America, rather than Europe, was the center of distribution for this family and that some or all of the Holarctic species migrated to Europe from the West.

As to the question of how many living insects survive extended aerial journeys and how often intercontinental migrations occur by this means, it seems probable that successful natural introductions of this sort are extremely rare. Otherwise, continental faunas would not be nearly so distinct as at present. The successful migration of insects across hundreds of miles of water is by no means a simple operation, and as the distance increases mathematical chances of introduction and survival decrease at an astonishing rate, according to Darlington's calculations (1938). Moreover, either a gravid or a parthenogenetic female is necessary for colonization, unless both sexes or eggs are carried to the same location. The difficulties met in man's attempts to colonize foreign insects for biological control purposes show that the establishment of a species in entirely new surroundings on the basis of a few individuals is often impossible. That, over a period of many centuries, aerial transport may have contributed to the small Holarctic percentage of our insect faunas is reasonable, however, particularly with psocids and other insects that are more susceptible to movement by air currents than large, heavily bodied insects like grasshoppers. McAtee (1917) and Darlington (1938, p. 281) have emphasized that minute and inconspicuous forms of animal life are much more likely to be carried in the air.

It is noteworthy that Glick (1939) collected by airplane nearly six times as many psocids as Orthoptera, and that only five specimens of Orthoptera were taken as high as 2,000 feet, and none higher. Though a few species of Orthoptera, notably migratory grasshoppers, occasionally make conspicuous flights in large numbers, they are plainly less adapted to movement by air currents than are psocids. This may be one explanation of the fact that comparatively many more psocids than Orthoptera are Holarctic.

One of the best examples of the aerial transportation of a large number of insects over a long interval of ocean is reported by Elton (1925). The Oxford expedition to Spitsbergen encountered large numbers of a syrphid fly and of a large black aphid alive on the snow, apparently after having been blown about 800 miles from the Kola Peninsula (near Murmansk in extreme northwestern Russia). Both species were previously unknown in Spitsbergen, and all the circumstances, even winds recorded by meteorologists as blowing from Europe over Spitsbergen immediately prior to the discovery of the insects, pointed to the correctness of Elton's suggestion that air currents brought about the introduction.

The studies of Dammerman (1922) and others who have collected on Krakatau have well demonstrated that substantial island faunas may be developed without the existence of land bridges, though it is true that without land connections certain large terrestrial animals are virtually excluded. The island of Krakatau, the fauna of which was destroyed by a volcanic eruption in 1883, is situated about 25 miles from the coasts of Sumatra and Java, with one or more small islands somewhat nearer to serve as possible stepping stones. A survey in 1908 yielded 15 species of spiders and 150 species of insects. A 1921 survey included 45 spider and 441 insect species, and, judging from observations on comparable islands of the region, Dammerman (1926) concluded that by 1921 Krakatau had attained approximately 60 percent of a normal fauna. The island was reinhabited by people in 1890, and there have undoubtedly been many artificial introductions of insects. The likelihood of successful introduction by air has been greatly increased by the nearness of richly populated land, compared with the situation affecting more isolated islands. Strong-flying insects, such as certain Odonata, Orthoptera, and Lepidoptera, probably migrated to Krakatau under their own power.[5]

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[5] A very comprehensive report on Krakatau has just been issued by Dammerman (1948).

Several theoretical studies of island faunas have been presented so logically as to strengthen the supposition that many suitably adapted insects have been successfully dispersed and colonized by air, though competition and other factors frequently react differently in island faunas than in mainland ones. Zimmerman (1942) believed that the bulk of the insects of the south central Pacific islands originated from stock brought by abnormal winds. It is striking and convincing that the only endemic groups of spiders in the Hawaiian Islands are types known to be frequently air-borne. Many Hawaiian insects lend themselves to being air-borne, either as single adults or as immature stages protected by a covering of plant material. "With few exceptions, the entire endemic beetle fauna of southeastern Polynesia is composed of small, predominantly flightless species that breed in dead twigs, dead leaves or in or under dead bark, and these forms are more extensively developed than any of the other groups of terrestrial animals in that region."[6]

Darlington (1938) believed that dispersal by air currents has played a significant role in the colonization of the principal islands of the West Indies, and that many insects, snails, and other small animals were carried from the mainland during storms. The distances are short, and conditions favor the transportation of many of the animal groups well represented in those islands.

DISTRIBUTIONAL AND SYNONYMIC NOTES

Philotarsus flaviceps (Stephens).—Two females taken from white spruce at Bar Harbor, Mount Desert Island, Maine, by A. E. Brower in July 1938 represent this species, not previously known in America though found throughout Europe. Procter (1946, p. 56) recorded the foregoing specimens as *Philotarsus* sp. The material there listed as *Philotarsus*, n. sp., has been examined through the kind cooperation of P. J. Chapman and Kathryn M. Sommerman, and it proves to be *flaviceps* also. That lot consists of two females collected at Southwest Harbor, Mount Desert Island, by C. P. Alexander, August 31 and September 12, 1926. The lack of conspicuous dark dots along the veins of the front wing readily separates *flaviceps* from *P. maculosus* (Aaron) of the Eastern United States (Aaron, 1883, p. 40, fig. 8). Readers are referred to Badonnel (1943, p. 71) for a well-illustrated description of *flaviceps*. The wing length of Maine specimens is 2.8 mm, slightly shorter than that of German material studied. The number of apical setae on the subgenital plate is four, or five, in different Maine specimens, four as figured by Badonnel. In Europe *flaviceps* occurs on many plants, especially spruce.

Psocus bifasciatus Latreille (= *P. confraternus* Banks) (new synonymy).—This species is widespread in both Europe and the United States, being known in Europe currently as *Amphigerontia bifasciata*. The difference in generic placement is due to the usual practice of writers in the United States using *Psocus* in a broad rather than a restricted sense (see Pearman, 1932). The latter's plan for dividing the genus *Psocus* of older authors will probably be adopted by American workers as revisionary studies permit the proper assignment of species. In both *Psocus bifasciatus* and *Philotarsus flaviceps*, I have made comparisons with specimens collected in Germany by A. M. Nadler.

Mesopsocus laticeps (Kolbe).—Dr. Sommerman has lent me an adult female and two nymphs beaten from pines by her mother, Mrs. A. H. Sommerman, July 7, 1947, at Mount Carmel, Conn. This is the first American record. Badonnel (1943) assigned *laticeps* to *Holoneura*. Kimmins (1941) selected *Hemerobius unipunctatus* Müller, 1764, as genotype of *Holoneura*, however, and that genus became a synonym of *Mesopsocus* through identical genotypes. In the original proposal of *Holoneura*, Tetens (1891) stated that the genus was erected for *laticeps*, with *unipunctatus* also included. The latter statement can not be clearly construed as a type designation,[7] so that Kimmins's selection was valid. It is quite evident that *laticeps* belongs to the same closely knit group of species as *unipunctatus* and other congeners, and I am not convinced that the features believed by Badonnel to distinguish *laticeps* generically from *unipunctatus* justify the description of another genus for the reception of the former species. Although *unipunctatus* is well established in Europe and North America, it was first reported from Iceland by Fristrup (1942a) who reported it as first noticed in 1934 and common in 1939. He expressed the belief that it had been recently introduced from Europe on nursery stock.

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[6] Zimmerman (1948) has recently presented, in the first volume of a notable work on Hawaiian insects, a detailed discussion of his views on the origin and dispersal of Pacific insects.

[7] I have discussed Teten's action with Secretary Hemming of the International Commission on Zoological Nomenclature.

Peripsocus.—Chapman (1930) suggested that *P. madescens* (Walsh) (U. S.) may be a synonym of *alboguttatus* (Dalman) (Europe) and that *quadrifasciatus* (Harris) (U. S.) may not differ from *subfasciatus* (Rambur) (Europe), but he felt there was insufficient evidence to definitely consider them to be synonyms. Navas (1915) reported specimens of *alboguttatus* and *subpupillatus* McLachlan (a synonym of *subfasciatus*) from White Plains, N. Y., both species representing new records from North America, though probably based on what American authors have called *madescens* and *quadrifasciatus*. I have compared European specimens of the two species with American material, but it still appears uncertain whether the American forms may not be at least subspecifically distinct. It should be noted that Kimmins's designation (1941) of *phaeopterus* (Stephens) as genotype of *Peripsocus* is antedated by Chapman's designation (1930) of the same species.

Psocathropos lachlani Ribaga (= *Psocinella slossonae* Banks (new synonymy).—Within the United States this tiny species with only a single pair of wings occurs primarily in the Southeastern States, and collections from houses are not rare. Banks's original specimens were taken while they were eating preserved insects in Florida, and Ribaga's type series was found in Italy. It is a species carried in commerce.

Cerobasis guestfalica (Kolbe).[8]—This species was first recorded from North America by Hagen (1882) under the name *Hyperetes tessulatus*. The latter was fully described by the same author (1883) from numerous specimens found in a museum building at Boston, Mass., where they were living with three common cosmopolitan psocid species. Enderlein (1905), Badonnel (1943), and others have treated *tessulatus* as a synonym of *guestfalica*, and Hagen's figures leave little doubt that *guestfalica* was involved. Since it is usually considered a free living, outdoor species, the indoor situation described by Hagen is of interest. Specimens of *guestfalica* have been intercepted at Philadelphia, Pa., in plant quarantine material from St. Thomas, Virgin Islands, and I have seen two small series from the eastern United States taken outdoors (Sommerman collection). Enderlein (1909) recorded a nymph of *tessulatus* from a Californian ants' nest, but the immaturity of the single specimen mentioned raises doubt as to the accurateness of the identification.

Myopsocnema annulata (Hagen).—This cosmopolitan, primarily indoor species was described by Hagen (1865) from specimens found in insect boxes at Konigsberg, Germany. Later he found a specimen at Cambridge, Mass., which was figured (1882, pl. 2, fig. 7), showing the typical dark brown blotches on the abbreviated front wings. The North American records of McLachlan (1883) and Banks (1907) are both probably based on Hagen's original reference.

In addition to two lots of *annulata* from Italy, I have seen three lots intercepted at Laredo and Brownsville, Tex., in plant-quarantine material from Mexico. An additional specimen was collected at Hot Springs, Ariz., June 21, 1901, by H. S. Barber.

The wings are easily shed if preserved specimens are roughly handled, and care is needed to distinguish wingless specimens from those of *Cerobasis guestfalica*, which normally have only a lateral stub remaining to represent the vestigial wing (see Badonnel, 1943, fig. 367). The head markings of *annulata* differ from those of *guestfalica*, in that the vertex is mottled rather than having two distinct longitudinal stripes, and also in the shape of the facial design and the absence of a punctate dark longitudinal stripe on the clypeus. Laing (1932) has compared *annulata* with *Trogium pulsatorium* (Linnaeus).

Lepinotus.—The cosmopolitan *L. inquilinus* Heyden is by far the most common species of the genus and is often collected from stored products in different parts of the United States. *L. reticulatus* Enderlein has been recorded from the United States by Pearman (1931) and Badonnel (1943), and in 1941 I collected a series at Cummington, Mass., about grain bins in a barn. The reticulate pattern of the wing, which distinguishes *reticulatus* from *inquilinus*, also occurs in *L. tasmaniensis* Hickman, 1934, and the possibility of the latter being a synonym deserves investigation. *L. patruelis* Pearman was recorded from California by Essig (1940).

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[8] *Hyperetes* Kolbe, 1880, is preoccupied by *Hyperetes* Rafinesque, 1815, and the name *Cerobasis* Kolbe, 1882, is here adopted. This seems preferable to *Tichobia* Kolbe, 1882, another synonym of *Hyperetes* Kolbe, which was proposed on the same page as *Cerobasis* but was not so fully characterized. Another generic name (*Teichobia* Herrich-Schaeffer, 1853, Lepidoptera) is spelled so nearly like *Tichobia* as to create possible confusion, and it may prove to be homonymous under opinion 147.

Pteroxanium kelloggi (Ribaga).[9]—This species was described from Stanford, Calif., in 1905, and Enderlein (1906) redescribed it from one of Ribaga's type specimens. There are no records of its having been collected again in this country. It appears to be well established in England, where it was first described as *P. squamosum* by Enderlein (1922). There the species is said to live under conditions comparable to those of a native insect (see Pearman, 1927; 1928; 1933), usually being "sheltered situations on fairly smooth-barked trees bearing a fine grey species of *Pleurococcus*," and even having been once recorded from a bird's nest. It was first recorded from the continent of Europe by Delamare-Deboutteville (1945). Pearman (1933) reported specimens from New Zealand. Later, Hickman (1934) described *Tasmanopsocus litoralis* from Tasmania, which has been placed in the synonymy of *kelloggi* by Badonnel (1943).

Liposcelis bicolor (Banks).—This species was described from Falls Church, Va., and was first reported from the Old World by Pearman (1925), who found it abundant under the bark of an old post in England. It has since been taken in Europe (Badonnel, 1943).

Counterpart species.—In many groups of animals certain species, occupying different areas, closely resemble each other. The separation of specimens occasionally may be difficult, though in at least one sex there appear to be adequate distinguishing characters. Each may occupy the same ecological niche in its respective distributional zone. In some cases subspecies will ultimately prove to be involved; others will probably remain distinct and they may be called counterpart species. *Ectopsocus californicus* (Banks) and *E. briggsi* McLachlan appear to be of this sort. Badonnel (1936) placed *californicus* as a synonym of *briggsi*, basing his knowledge of *californicus* on the illustrations by Chapman (1930), but later (1943) he states that, according to Pearman, the species are distinct. I have been unable to separate females, but males examined from Europe and North America differ in the structure of the penial armature (that of *briggsi* illustrated by Badonnel (1943, fig. 249)).

Summary.—The 18 species of psocids known to occur in both North America and Europe are listed, and several are recorded from America for the first time. At least 10 species are carried in commerce, so that only about 6 percent or less of Nearctic species are believed to be truly Holarctic. The number of Holarctic species in other insect orders varies, sometimes running as high as 15 percent of the Nearctic species, again representing no more than 1 percent. It is believed that air currents may have been a significant factor contributing to the wide distribution of the relatively few Holarctic psocids, and evidence indicating the logic of that view is presented. Notes are given on the distribution and synonymy of several not well known or previously unrecorded North American psocids that also occur in Europe.

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[9] *Lepidilla* Ribaga, 1905, is preoccupied by *Lepidilla* Matthew, 1885, and *Pteroxanium* Enderlein, 1922, is the next available name.

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ZOOLOGY.—*The amphipod genus* Corophium *on the west coast of America.*[1] CLARENCE R. SHOEMAKER, Associate in Zoology, U. S. National Museum.

Up to the present time five species of *Corophium* have been described from the west coast of America, and three additional species occur on both the east and west coasts. Five species are now being described from the west coast as new to science. In conformity with my paper on the east coast species of *Corophium*,[2] I am following the scheme used by G. I. Crawford (Journ. Marine Biol. Assoc. **21** (2): 589–630. 1937) by dividing the species into three sections according to the characters of the urosome. The west-coast species fall into three sections:

SECTION A: Segments of urosome separate.
  1. Antenna 2, segment 4 different in ♂ and ♀.
    C. salmonis, p. 66
    C. stimpsoni, p. 68
    C. panamense, n. sp., p. 68
    C. brevis, n. sp., p. 70
    C. setosum, n. sp., p. 72
  2. Antenna 2, segment 4 alike in ♂ and ♀.
    C. spinicorne, p. 74
SECTION B: Segments of urosome fused; uropods 1 and 2 inserted in notches in the lateral margins.
  1. Antenna 2, segment 4 different in ♂ and ♀.
    C. acherusicum, p. 76
    C. crassicorne, p. 76
    C. californianum, p. 76
    C. insidiosum, p. 77
    C. clarencense, n. sp., p. 78
  2. Antenna 2, segment 4 alike in ♂ and ♀.
    C. oaklandense, n. sp., p. 80
SECTION C: Segments of urosome fused; uropods 1 and 2 attached ventrally; lateral margins of urosome without notches.
  1. Antenna 2, segment 4 different in ♂ and ♀.
    C. baconi, p. 82
  2. Antenna 2, segment 4 alike in ♂ and ♀.
    No species.

Corophium salmonis Stimpson

Fig. 1

Corophium salmonis Stimpson, Boston Journ. Nat. Hist. **6**: 514. 1857.
Corophium salmonis Bradley, Univ. California Publ. Zool. **4**: 235, pls. 11, 12. 1908.
Corophium salmonis Crawford, Journ. Marine Biol. Assoc. **21**: (2) 603. 1937.

Male.—Head with front between the side lobes straight, slightly convex, or with a very low central obtuse-angular projection; eyes dark, small and rather indistinct. Antenna 1 reaching just beyond the middle of the fourth joint of antenna 2; first joint with inner margin expanded into a broad rounding lobe, which, in fully grown males, overlaps that of the opposite antenna, lower margin of joint bearing a distal spine; second joint slender and not quite so long as the first joint; third joint a little over half the length of the second; flagellum about equal in length to the peduncle and composed of about 14 joints. Antenna 2 much longer than the entire body in fully grown specimens; first joint half the length of the third; second joint bearing a short, blunt, forward-curving gland-cone; third joint nearly half the length of the fourth; fourth joint with lower margin produced distally into a strong curved tooth above which is a small tooth; fifth joint nearly as long as the fourth, armed proximally below with a sharp triangular tooth and distally with an acute downward-curving lobe; flagellum about half the length of the fifth peduncular joint and composed of one long joint and two or three short joints.

Gnathopod 1, sixth joint with palm about transverse, convex, finely dentate throughout, armed on the outside and inside surface with a row of five or six short slender submarginal spines, and defined by a single spine; seventh joint slender and slightly overlapping palm. Gnathopod 2, seventh joint slender and armed on the inner margin with four or five rather small teeth. Peraeopods about normal.

Uropod 1, outer margin of peduncle armed distally with a row of two or three spines and proximally with three to six slender spinules, inner margin with a single distal spine, the distal peduncular lobe is small and acutely triangular; both rami with a row of spines on the outer margin and none on the inner margin. Uropod 2, outer margin of peduncle with a single distal spine, inner margin without spines, outer ramus usually without spines on either margin, inner ramus with three or four spines on outer margin and none on inner. Uropod 3, ramus longer than peduncle, oval, and bearing long slender spines on all margins. The largest males are about 6 mm from front of head to end of uropods.

Female.—The female differs from the male

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[2] Journ. Washington Acad. Sci. **37**: 47–63, figs. 1–12, 1947.

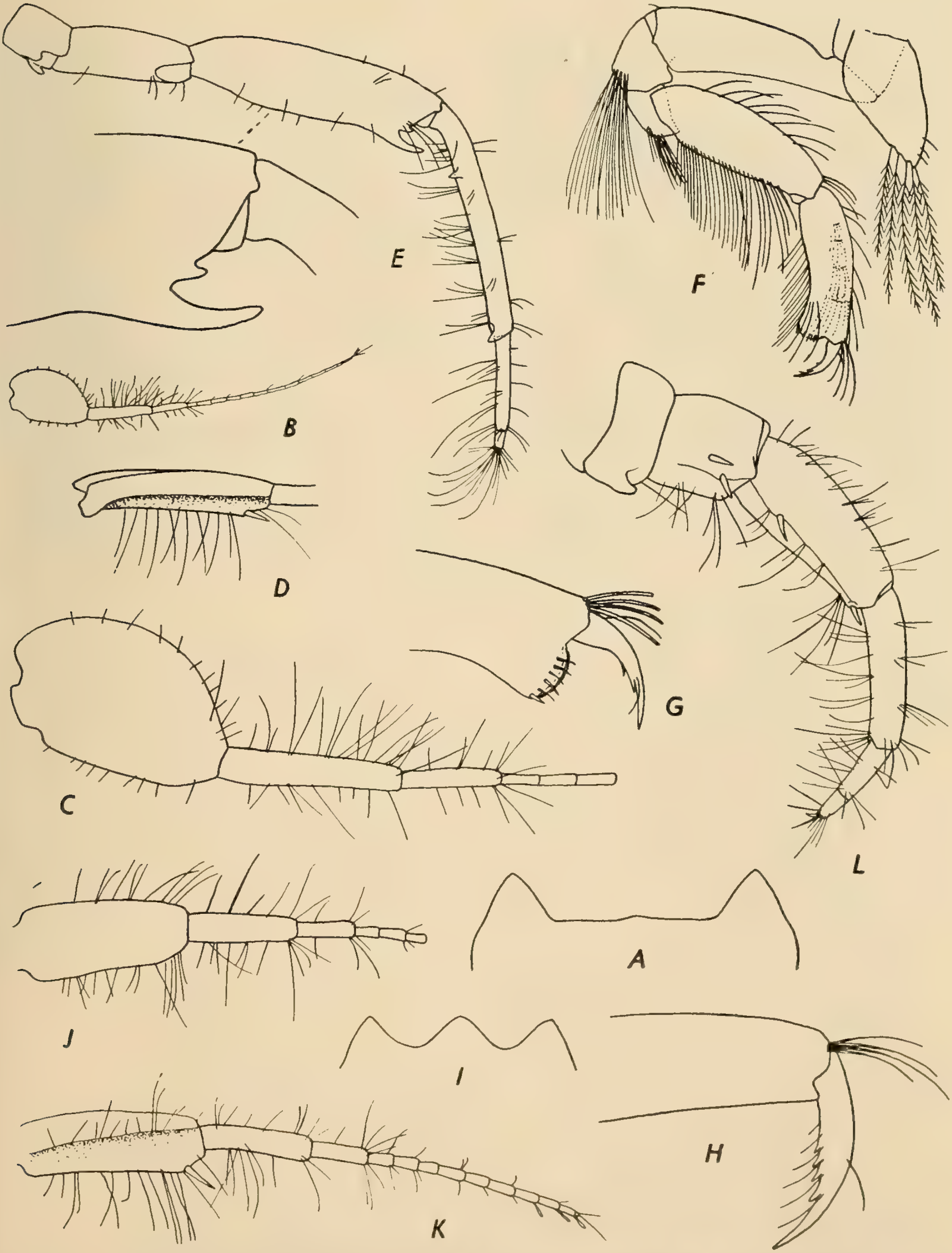

FIG. 1.—*Corophium salmonis* Stimpson. Male: *a*, Front of head from above; *b*, right antenna 1 from above; *c*, right antenna 1 much enlarged; *d*, right antenna 1, side view; *e*, left antenna 2, inside view; *f*, gnathopod 1; *g*, end of gnathopod 1 much enlarged; *h*, end of gnathopod 2 much enlarged. Female: *i*, Front of head from above; *j*, right antenna 1 from above; *k*, right antenna 1, side view; *l*, left antenna 2, inside view.

principally in the antennae. Head, front between the side lobes forming a low broad triangle. Antenna 1 about as long as antenna 2, peduncle reaching to about the distal end of fourth joint of antenna 2; first joint somewhat expanded, but without the broad inner lobe of the male, lower margin bearing a distal spine; second joint slender and about two-thirds as long as the first; third joint over half the length of second; flagellum much shorter than peduncle and composed of about ten joints. Antenna 2 about half the length of the body; second joint with gland-cone larger and more prominent than in the male; third joint bearing two spines on inner surface; fourth joint about twice as long as third, the lower inner surface produced into a low ridge which bears a distal spine and one proximally to the center; fifth joint a little shorter than fourth and without spines; flagellum about two-thirds the length of the fifth peduncular joint and composed of one long and two or three short joints.

Gnathopods and peraeopods are like those of the male. Uropod 1, peduncle with the usual triangular distal lobe, outer margin of peduncle with four distal spines and three proximal slender spinules, inner margin with one apical spine; outer ramus with four spines on outer margin and none on inner margin; inner ramus with five spines on outer margin and none on inner margin. Uropod 2, peduncle with one apical spine on outer margin and none on inner margin; outer ramus usually without spines on either margin; inner ramus with two or three spines on outer margin and none on inner margin. Uropod 3 as in male. Length of female from front of head to end of uropods about 7 mm.

All the specimens in the National Museum collection were taken from Puget Sound, Wash., from muddy bottoms. The specimens which were studied by J. Chester Bradley were from stomachs of fishes taken by the U. S. Bureau of Fisheries in Kurlak Estuary, Kodiak Island, Alaska.

Remarks.—Bradley's figures, 22 and 23 on plate 11, are not the antennae of the female of *C. salmonis*. His figure 22 of the second antenna bears a distal tooth on the fourth joint as in the male, whereas this joint in the female of *C. salmonis* bears only a spine distally as shown by my Fig. 1, *l*. Bradley's figure 24 is the second antenna of the female of *C. salmonis* and not that of a young male.

Corophium stimpsoni Shoemaker

Fig. 2

Corophium stimpsoni Shoemaker, Proc. Biol. Soc. Washington **54**: 184. 1941.

This species is smaller, but resembles *C. salmonis*, especially in the female, but there are certain characters by which the two species can be recognized. Inasmuch as I have fully described *C. stimpsoni* elsewhere (1941, *loc. cit.*), I give here only those characters that distinguish it from *C. salmonis*.

Male.—The front margin of the head between the side lobes produced and evenly rounded (Fig. 2, *a*). Antenna 1 reaching to the distal end of the fourth joint of antenna 2; first joint moderately expanded above, lower inside surface bearing a downward- and forward-curving lobe proximally, and without spines on lower margin. Antenna 2 about as long as the body; the proximal tooth on the lower margin of the fifth joint closes within the large tooth of the fourth joint. Length of male about 5 mm from front of head to end of uropods.

Female.—The female of *C. stimpsoni* and that of *C. salmonis* appear to be alike and I do not find any characters which can be relied upon to distinguish them. The female of *C. stimpsoni* is a little the smaller, measuring about 6 mm from front of head to the end of the uropods.

Corophium stimpsoni was described from Dillon Beach, Marin County, Calif. It has since been taken in Elkhorn Slough, near Pacific Grove, Monterey Bay; west shore of San Francisco Bay near Point San Quentin; Tomales Bay, Marin County; and Stempell Creek, Mendocino County, Calif.

Corophium panamense, n. sp.

Fig. 3

Male.—Head without rostrum, front between lateral lobes straight or slightly concave; lateral lobes short, angular and narrowly rounding distally. Eyes oval and dark brown. Antenna 1 reaching beyond middle of fifth joint of antenna 2; first peduncular joint rather broad dorsally, inner margin bearing proximally a row of long forward-curving setae and a row of shorter spinules distally, outer margin bearing a few short spinules, lower margin bearing scattered spinules and distally a forward-pointing spine; second joint slender and about two-thirds as long as the first; third joint less than half the length of the second; flagellum longer than peduncle and composed of about seventeen joints. Antenna 2, first three joints without spines; fourth joint stout and strong, lower margin bearing groups of long setae and produced distally into a strong forward-curving tooth above which are two smaller teeth; fifth joint a little shorter than the fourth, lower margin bearing groups of long setae, and proximally a low rounding protuberance; flagellum composed of one long and two or three short joints, lower margin of first joint bearing groups of setae which are much longer than those of the fourth and fifth peduncular joints.

Gnathopod 1, sixth joint with palm nearly transverse, slightly convex and armed through-

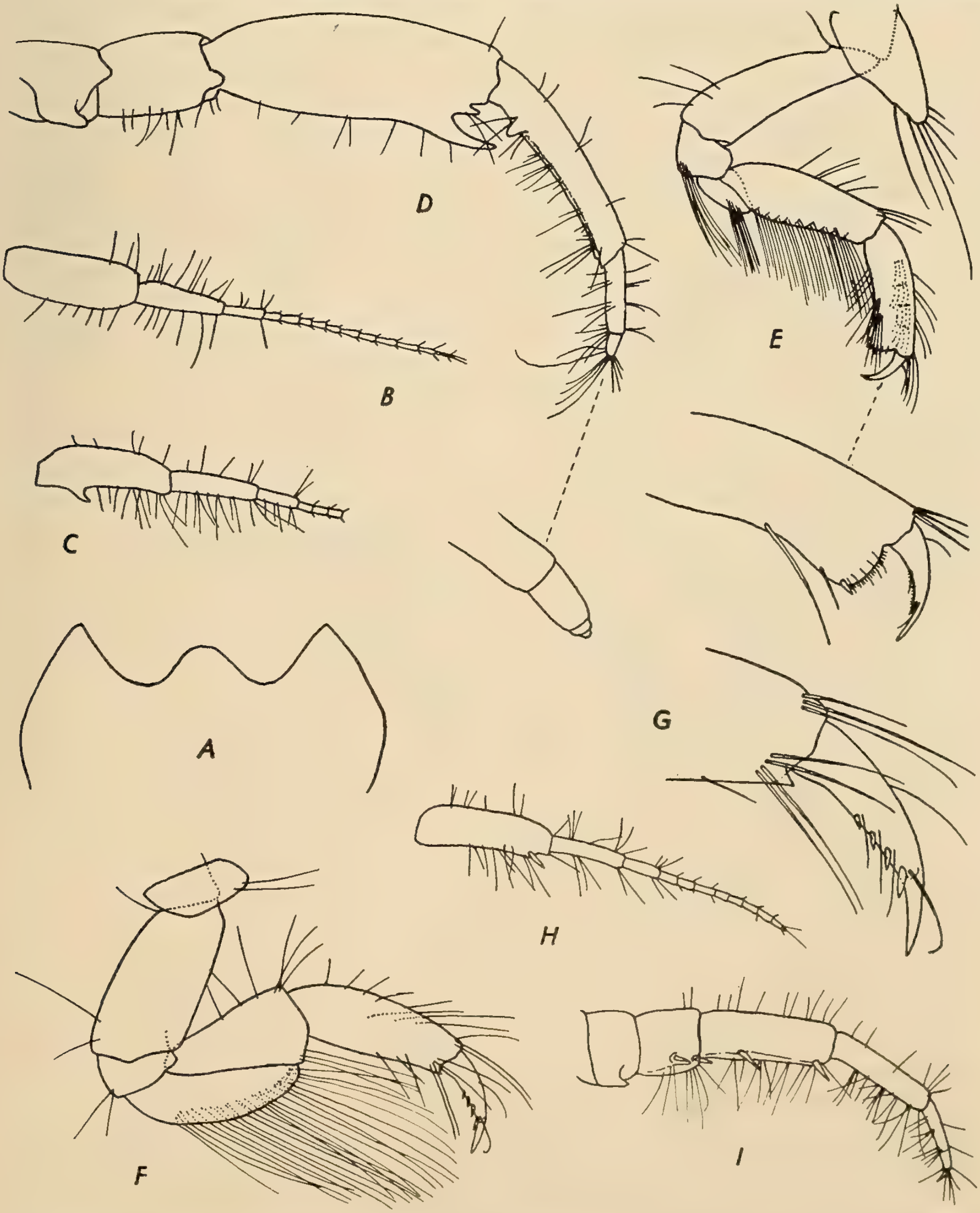

FIG. 2.—*Corophium stimpsoni* Shoemaker. Male: *a*, Front of head from above; *b*, right antenna 1 from above; *c*, right antenna 1, side view; *d*, right antenna 2, inside view; *e*, gnathopod 1; *f*, gnathopod 2; *g*, end of gnathopod 2 much enlarged. Female: *h*, Right antenna 1, side view; *i*, left antenna 2, inside view.

out with very fine serrations; seventh joint overlapping palm, and armed on inner margin with very fine serrations, and a forward-pointing tooth near the apex. Gnathopod 2, seventh joint bearing two teeth on inner margin. Uropod 1, peduncle bearing three spines on distal half of outer margin, and four on inner margin, the lower distal end produced into a prominent spatulate lobe; outer ramus bearing beside the distal spines four on the outer margin and none on the inner margin; inner ramus bearing three spines on outer margin and none on the inner margin. Uropod 2, rami without lateral spines; uropod 3, ramus narrow, longer than peduncle and bearing long slender spines distally. Length of male from front of head to end of uropods 3.5 to 4 mm.

Female.—Head with very short triangular rostrum (Fig. 3, *k*). Antenna 1 very nearly as long as antenna 2; inner margin of first joint of peduncle bearing three proximal spines and many long forward-curving setae distally, lower margin bearing two distal forward-pointing spines; flagellum nearly as long as peduncle and composed of about nine joints. Antenna 2 smaller and not so strong as in male; second joint bearing one small spine on lower distal end; third joint bearing two spines on lower distal end; fourth joint with lower margin produced distally into a blunt rounding lobe bearing two spines, two spines about the middle of the lower margin, and, in the young, two spines on inner surface; fifth joint bearing a stout spine at middle of lower margin; flagellum composed of one long and two or three short joints. Uropod 1, peduncle without the prominent spatulate lobe, but bearing a short triangular projection. Length from front of head to end of uropods about 3.5 mm.

Type.—A male, U.S.N.M. no. 84879, taken at San José Island, Pearl Islands, Republic of Panama, March 21, 1944. This specimen was taken from muddy leaves in a pool just above the low tide line of east-northeast tributary of Río Mata Puerco Swamp at edge of mangroves, by Dr. J. P. E. Morrison.

Remarks.—The location where this species was taken is in the transition zone, where at low tide the water is fresh and at high tide the salt water is backed up. *C. rioplatense* Giambiagi and the *Corophium* species[3] taken by Dr. Leonard P. Schultz in Ciénaga del Guanavana (swamp) just north of Sinamaica, Venezuela, were found living under similar habitat conditions as *C. panamense.* These three species possess many characters in common, but *C. panamense* possesses characters which appear to distinguish it from *C. rioplatense.* In *C. p.* the fourth joint of the second antenna of the male has above the large distal tooth a smaller double-pointed tooth, while in *C. r.* this smaller tooth is single-pointed. In the male of *C. p.* the rami of the second uropod have no lateral spines, while in *C. r.* there is one spine on the outer margin of each of these rami. The first uropod of the male of *C. p.* has lateral spines on both margins of its peduncle, while in *C. r.* there are spines only on the outer margin. The flagellum of the first antenna in the male of *C. p.* is longer than the peduncle and is composed of about 17 joints, while in the male of *C. r.* it is shorter than the peduncle and contains only six or seven joints. In the female of *C. p.* the first peduncular joint of the first antenna has three proximal spines on inner margin, while *C. r.* has apparently one or two; the lower margin of this joint in *C. p.* has two distal spines, while that of *C. r.* has only one. In the second antenna of the female of *C. p.* the fourth joint has only two spines on the distal lobe and two centrally located spines on lower margin; the inner surface of this joint is without spines except in the young males. In *C. r.* this fourth joint has a row of spines both on the distal lobe and lower margin, and the inner surface bears two spines. The fifth joint of the second antenna of the female in *C. p.* bears a stout spine on the lower margin, while in *C. r.* there is a low protuberance bearing a small spine. The head of the female of *C. p.* has a small triangular rostrum, but in the female of *C. r.* there is no rostrum.

Corophium brevis, n. sp.

Fig. 4

Male.—Head with front obtusely triangular, but can scarcely be termed rostrate; lateral lobes sharp and triangular; eyes small and black. Antenna 1 reaching a little beyond the end of fourth joint of antenna 2; first joint without spines on inner margin, but fringed with rather long setae, lower margin with a small distal spine and a downward-projecting protuberance proximally; second joint a little shorter than the first, and more than twice as long as the third; flagellum not quite as long as the peduncle and com-

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[3] Journ. Washington Acad. Sci. **37**: 49. 1947.

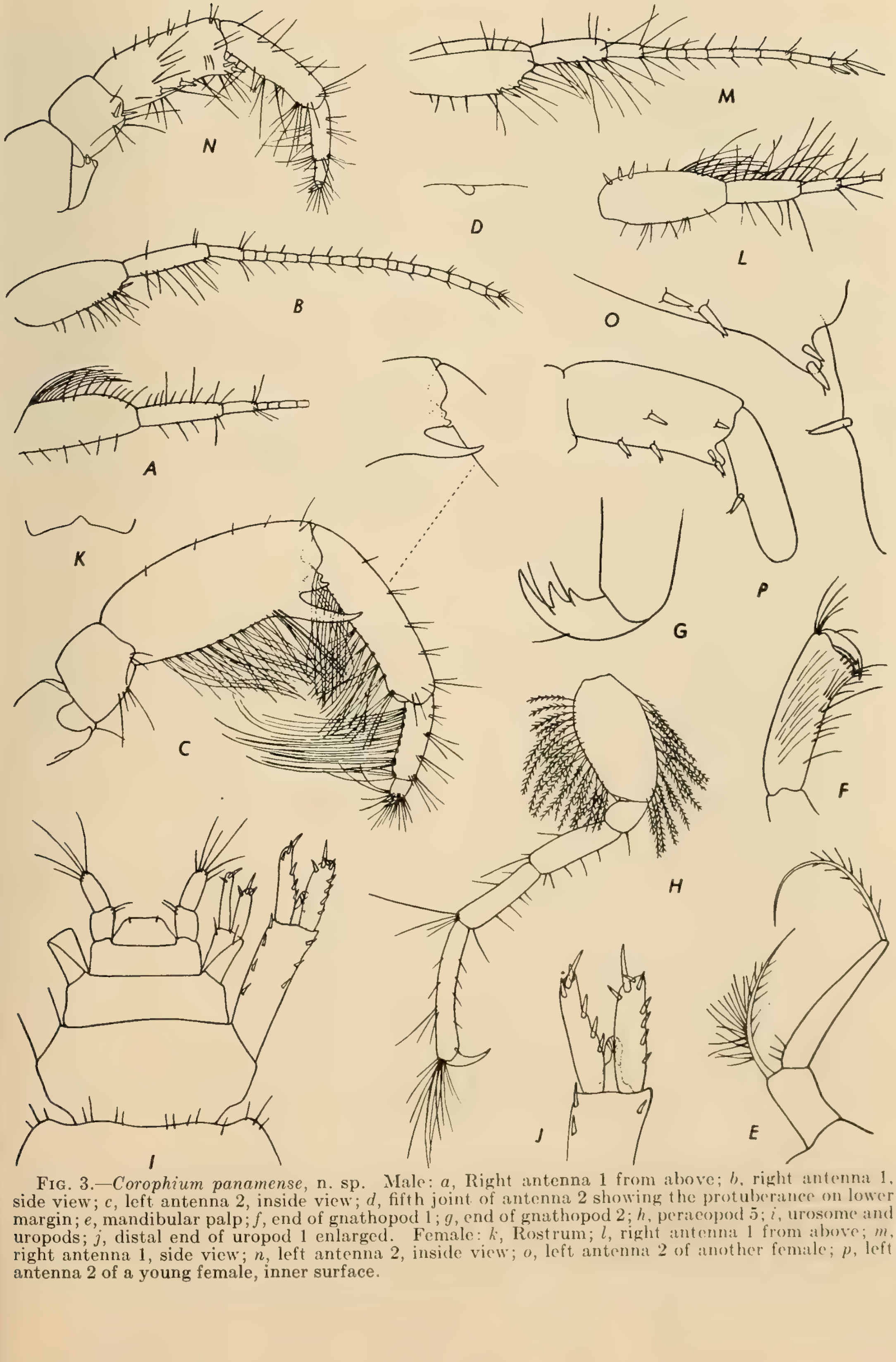

FIG. 3.—*Corophium panamense*, n. sp. Male: *a*, Right antenna 1 from above; *b*, right antenna 1, side view; *c*, left antenna 2, inside view; *d*, fifth joint of antenna 2 showing the protuberance on lower margin; *e*, mandibular palp; *f*, end of gnathopod 1; *g*, end of gnathopod 2; *h*, peraeopod 5; *i*, urosome and uropods; *j*, distal end of uropod 1 enlarged. Female: *k*, Rostrum; *l*, right antenna 1 from above; *m*, right antenna 1, side view; *n*, left antenna 2, inside view; *o*, left antenna 2 of another female; *p*, left antenna 2 of a young female, inner surface.

posed of about eleven joints. Antenna 2, fourth joint with lower margin produced distally into a strong forward-curving tooth above which is a smaller tooth; fifth joint nearly as long as fourth, with distal end produced on the inner side into a sharp triangular tooth, and the lower margin bearing a sharp tooth proximally; flagellum composed of one long and two short joints; the lower margins of the fourth and fifth peduncular joints and the flagellum bearing groups of long setae.

Gnathopod 1, sixth joint with palm oblique and rounding, armed on the outer and inner margins with three or four spines each, finely pectinate throughout, and defined by two stout spines; seventh joint overlapping palm, inner margin finely pectinate, bearing three or four spinules, and a forward-pointing tooth distally. Gnathopod 2, seventh joint with five or six teeth on inner edge.

Uropod 1, peduncle with a sharp triangular lobe distally, a row of about eight spines on outer margin and a single distal spine on inner margin; outer ramus with four or five spines on outer edge besides the usual terminal spines and no spines on inner margin; inner ramus with three or four lateral spines on outer margin in addition to the terminal spines and no spines on inner margin. Uropod 2 with two lateral spines on the outer edge of each ramus and no spines on inner margin. Uropod 3 short, peduncle and ramus subequal in length, ramus provided distally with long slender spines. Length of male from front of head to end of uropods 3.5 mm.

Female.—Front of head like that of male. Antenna 1, first joint rather broad dorsally, inner margin with two or three spines proximally and many long setae, lower margin with distal half produced downward into a broad lobe bearing four or five spines and several long setae; second joint about two-thirds as long as the first and twice as long as the third; flagellum shorter than peduncle and composed of about 7 or 8 joints. Antenna 2 rather short and stout; second joint with gland-cone broad distally and bearing a small apical spine; third joint bearing three spines on lower distal corner; fourth joint with three equally spaced pairs of spines on lower margin; fifth joint shorter than fourth and without spines; flagellum about two-thirds as long as the fifth joint and composed of one long joint and two or three short joints.

Gnathopod 1 like that of male. Gnathopod 2, seventh joint with five or six teeth on inner edge. Uropod 1, peduncle produced distally into a triangular lobe as in the male, outer margin bearing seven or eight spines, inner margin with only a single apical spine; outer ramus with three spines on outer margin and none on inner margin; inner ramus with four spines on outer margin and none on inner margin. Uropod 2 with one spine on the outer margin of each ramus and none on the inner margin. Uropod 3 as in male except that the ramus is somewhat longer than the peduncle. Length of female from front of head to end of uropods about 4 mm.

Type.—A male, U.S.N.M. no. 80489, taken in Whollochet Bay, South Puget Sound, Wash., from wharf piling, July 30, 1930, collected by E. F. Ricketts.

Besides the type locality, Puget Sound, this species has been taken in San Francisco Bay and Humboldt Bay, Calif.; Clayoquot, Vancouver Island; and Stephens Passage, Alaska.

Corophium setosum, n. sp.

Fig. 5, *a-f*

Female.—Head, rostrum very small, narrow and sharp-pointed; eyes small, brownish and ill defined. Antenna 1 nearly as long as antenna 2; first joint moderately expanded dorsally, three spines proximally and several long setae distally on the inner margin, lower margin with three spines and several long setae on distal half; second joint over half the length of the first and twice as long as the third; flagellum much shorter than the peduncle and composed of five or six joints. Antenna 2 short and stout and about half as long as the body; second joint with prominent gland-cone bearing an apical spinule; third joint with a stout spine on lower margin; fourth joint two-thirds as deep as long, lower margin with three tubercles each bearing a spine, inner surface with three equally spaced forward-pointing spines; fifth joint about two-thirds as long as the fourth, produced distally into a prominent downward-curving tooth, lower margin bearing a spine near the middle, and the inner surface bearing three equally spaced forward-pointing spines; flagellum about two-thirds as long as the fifth joint and composed of one long and one or two very short joints.

Gnathopod 1, sixth joint with palm oblique, very convex, passing without defining angle into the hind margin of joint, finely pectinate throughout, armed with three submarginal spines and several slender spinules, and defined by a stout

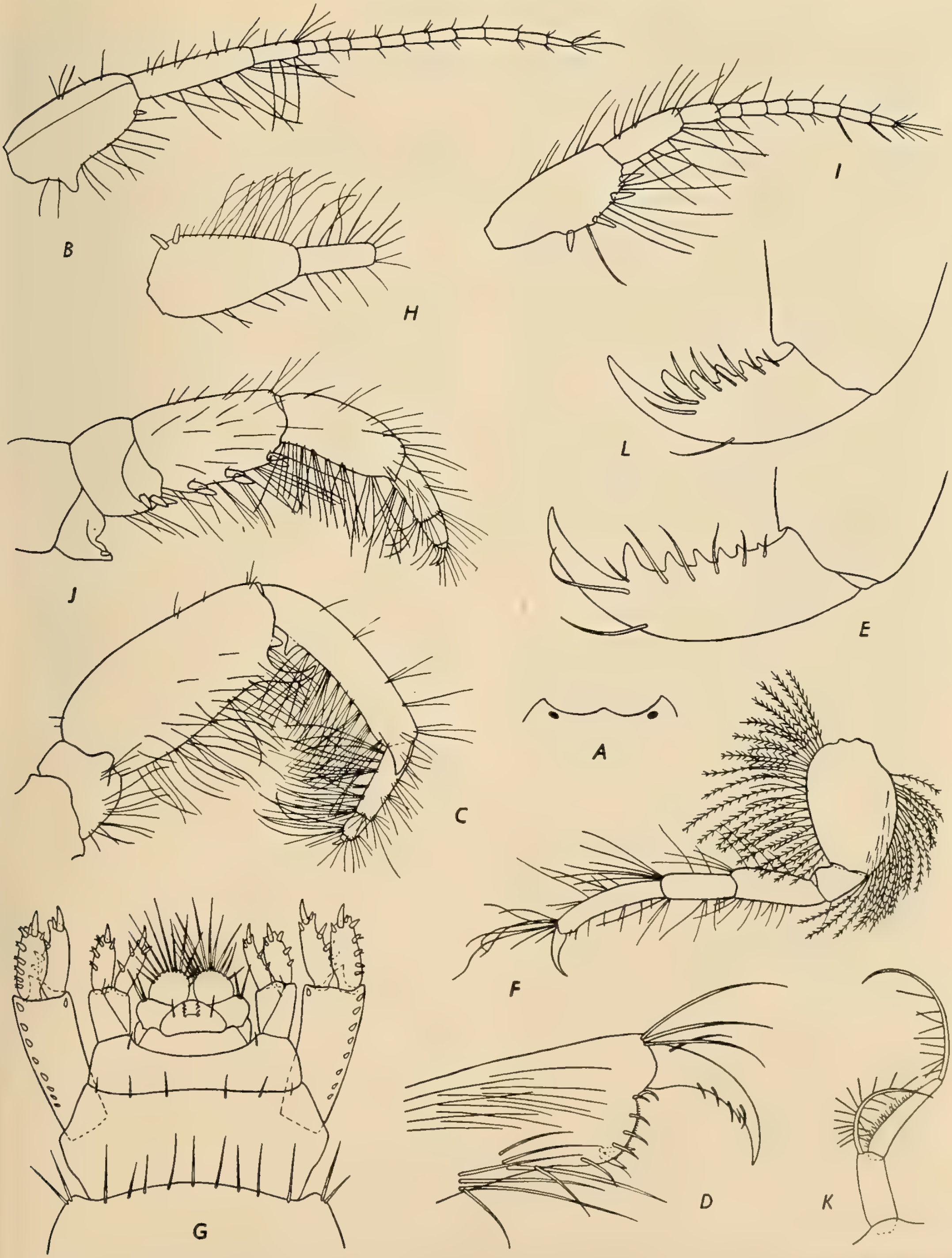

FIG. 4.—*Corophium brevis*, n. sp. Male: *a*, Rostrum; *b*, right antenna 1, side view; *c*, left antenna 2, inside view; *d*, end of gnathopod 1; *e*, end of gnathopod 2; *f*, peraeopod 5; *g*, urosome and uropods. Female: *h*, Right antenna 1 from above; *i*, right antenna 1, side view; *j*, left antenna 2, inside view; *k*, mandibular palp; *l*, end of gnathopod 2.

spine; seventh joint as long as palm, finely pectinate on inner margin and bearing a forward-pointing tooth distally. Gnathopod 2, seventh joint armed on inner margin with two stout teeth. Uropod 1, peduncle bearing distally a triangular lobe; outer margin with seven rather long spinules and a distal spine, inner margin with a small distal spine; outer ramus with four spines on outer margin and none on inner margin; inner ramus with four spines on outer margin and none on inner margin. Uropod 2, peduncle bearing two slender spinules on outer margin and none on inner margin; outer ramus with one spinule on outer margin and none on inner margin; inner ramus with two slender spinules on outer margin and none on inner margin. Uropod 3, peduncle bearing two slender spinules on outer margin and two on inner margin; ramus longer than peduncle with long slender spinules on apex and outer margin. Telson short and broad. Length of female from front of head to end of uropods 2 mm.

Type.—An ovigerous female, U.S.N.M. no. 84988, taken in Tenacatita Bay, Jalisco, Mexico, by Dr. Waldo L. Schmitt, March 18, 1933, while a member of the Hancock Galápagos Expedition.

The two females taken in Tenacatita Bay by Dr. Schmitt are the only known specimens of this species.

Corophium spinicorne Stimpson

Fig. 6

Corophium spinicorne Stimpson, Boston Journ. Nat. Hist. **6**: 514. 1857.
Corophium spinicorne Stimpson, Proc. California Acad. Sci. **1**: 89. 1857.
Corophium spinicorne Bradley, Univ. California Publ. Zool. **4**: 227. pls. 9, 10. 1908.
Corophium spinicorne Essig, Pan-Pacific Ent. **1**(4): 189. 1925.
Corophium spinicorne Crawford, Journ. Marine Biol. Assoc. **21**(2): 604. 1937.

Male.—Head, front slightly convex but without rostrum. Antenna 1 reaching to about the middle of the fifth joint of antenna 2, first peduncular joint little expanded dorsally, inner margin without spines but having long and short setae, lower margin with long setae but no spines; second joint slender and as long as the first; third joint about half as long as the second; flagellum a little shorter than the peduncle and composed of from fourteen to sixteen joints. Antenna 2 in old males is as long as or longer than the body, second peduncular joint bearing a prominent, conical, forward-curving gland-cone; third joint with a low protuberance distally, and one proximally on the lower inner margin; fourth joint stout and strong, lower margin produced distally into a strong forward-curving tooth; fifth joint nearly as long as the fourth and bearing a sharp tooth proximally and a sharp tooth on the inner distal end; flagellum about two-thirds as long as the fifth joint and composed of one long and several short terminal joints.

Gnathopod 1, sixth joint with palm oblique, slightly convex, finely pectinate, armed on the inner and outer margin with a row of short curved slender spinules and defined by a stout spine; seventh joint not overlapping palm, finely pectinate on inner edge and bearing a forward-pointing tooth distally. Gnathopod 2, seventh joint with four to six teeth on inner edge. Uropod 1, peduncle with sharp triangular distal lobe, outer margin with as many as twelve long setae and one terminal spine, inner margin with one terminal spine; outer ramus with from five to seven spines on outer margin and none on inner margin; inner ramus with from four to six spines on outer margin and none on inner margin. Uropod 2, peduncle with one or two long setae distally on outer margin and none on inner margin; outer ramus with two long setae on outer margin and none on inner; inner ramus with one lateral spine on outer margin and none on inner margin. Uropod 3, ramus a little longer than peduncle and armed distally with long slender setae which extend half way or farther down the outer margin. The male reaches a length of 8 mm from front of head to end of uropods.

Female.—Much like the male but stouter. Head without rostrum, front slightly convex as in male. Antenna 1, lower margin of first joint, besides long setae, may or may not have a distal spine, and there may be one, two, or no proximal spines. Antenna 2 over one-half the length of the body; gland-cone very prominent, curving forward, with sharp, narrow apex; fourth joint like that of the male, but smaller and weaker; fifth joint with a stout tooth at distal end and a strong tooth proximally on lower margin. When this joint is flexed the proximal tooth opposes the long tooth of the fourth joint, whereas in the male it is decidedly proximal to the tooth of the fourth joint when the fifth joint is flexed. Gnathopods like those of the male.

Uropod 1, peduncle like that of the male; outer ramus with as many as ten spines on outer margin and none on the inner margin; inner ramus with about seven spines on outer margin and none on the inner margin. Uropod 2, peduncle with one or two slender setae distally on the outer margin and none on the inner margin; outer ramus with about four setae on outer margin and none on inner margin; inner ramus with one or two spines on outer margin and none

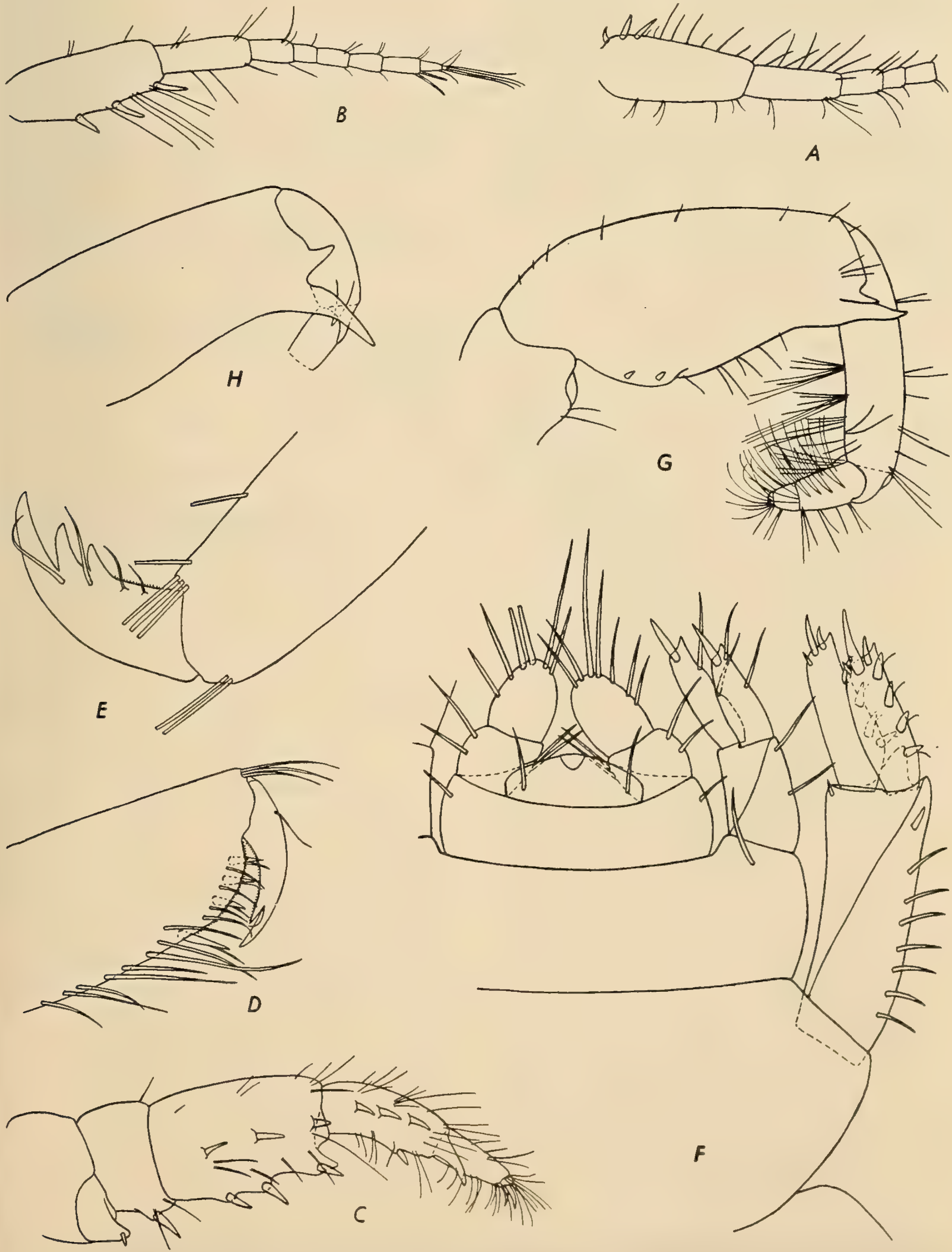

Fig. 5.—*Corophium setosum*, n. sp. Female: *a*, Right antenna 1 from above; *b*, right antenna 1, side view; *c*, left antenna 2, inside view; *d*, end of gnathopod 1; *e*, end of gnathopod 2; *f*, urosome and uropods. *Corophium baconi* Shoemaker. Male: *g*, Left gnathopod 2, inside view: *h*, left gnathopod 2, viewed from above.

on the inner margin. Uropod 3, ramus longer than peduncle and armed distally with long slender setae which extend halfway down the outer margin. Large females reach a length of 10 mm from front of head to end of uropods.

Remarks.—J. Chester Bradley (1908, p. 231, pl. 9, fig. 1) states that there are two stout spines proximally on the lower margin of the fifth joint in the female. I have examined a great many females of this species and have not seen a specimen with two spines or teeth. He also describes and figures (1908, p. 231, pl. 9, figs. 5, 6) what he believed to be a young female, but his figures resemble the female of *C. insidiosum* Crawford, which species occurs on the west coast. The young females of *C. spinicorne* do not differ materially from the older females.

C. spinicorne is the largest species of *Corophium* on the west coast. It inhabits the brackish waters of the bays and estuaries and a male specimen was sent to the U. S. National Museum in 1924 from the fresh water of the water system of the city of San Francisco, Calif., where it was said to be quite numerous. On April 5, 1936, males and females were taken by A. Ekenberg in Merced Lake, where the species was said to be abundant. The water supply of San Francisco was partially drawn from this lake in 1924, so it is quite probable that the male sent to the National Museum at that time came originally from the lake. Five specimens of this species (4 males and 1 female) were taken in the Sacramento River at Isleton, Sacramento County, Calif., March 9, 1948, by O. B. Cope. The water of the river at this place is said to be fresh, especially in March, which is the wet season.

These are the only records of the occurrence of *Corophium* in the fresh waters of America. *C. spinicorne*, as shown by material in the U. S. National Museum, ranges from Waddell Creek, Santa Cruz County, Calif., to Amchitka Island, Alaska, where fine specimens of males and females were taken in a lake, but it is not stated whether the water of the lake was fresh, brackish, or salt. Fine specimens were taken from a slightly brackish rill at the west edge of Oak Harbor, Whidbey Island, Island County, Wash.

Corophium acherusicum Costa

Corophium acherusicum Costa, Mem. Accad. Sci. Napoli **1**: 232. 1857.
Corophium acherusicum Shoemaker, Journ. Washington Acad. Sci. **37**: 53, figs. 2, 3. 1947.

This widely distributed species is well represented on both the east and west coasts of North America. In the collection of the U. S. National Museum there are specimens from the coast of California taken at Newport Bay, Orange County; San Pedro Harbor, Los Angeles County; and San Francisco Bay; Departure Bay, Vancouver Island; and Pender Harbor, British Columbia. The *Albatross* took many specimens of this species during its survey of San Francisco Bay in 1912 and 1913. In my *Notes on the genus* Corophium *on the east coast* (1947, p. 53), I recorded this species from Alaska; but I am now unable to locate any specimens north of Pender Harbor, British Columbia.

Corophium crassicorne Bruzelius

Corophium crassicorne Bruzelius, Kongl. Svenska Vet.-Akad. Handl. Stockholm (n. ser.) **3**(1): 15, pl. 1, fig. 2. 1859.
Corophium crassicorne Shoemaker, Journ. Washington Acad. Sci. **37**: 53, fig. 4. 1947.

This species extends from southern Spitzbergen and Berents Sea along the European coasts (including the Faroes) to the Black Sea (Stephensen, 1942). In 1944 it was recorded from Scoresby Sound, East Greenland, by Stephensen. On the east coast of America it extends from the Bay of Fundy to Gardiner's Bay, Long Island, N. Y. On June 20, 1873, Dr. W. H. Dall took two fully developed females at Chichagof Harbor, Attu Island, Alaska, which is the only record for the west coast of America.

Corophium californianum Shoemaker

Corophium californianum Shoemaker, Journ. Washington Acad. Sci. **24**: 359, fig. 2. 1934.

The only specimen of this species which has been discovered is the type male, measuring about 3 mm, which was taken from the holdfast of water-logged kelp dredged in 48 fathoms in Monterey Bay, Calif., by the Pacific Biological Laboratories. The type, no. 66880, is in the collection of the U. S. National Museum.

As the uropods of this species have not been described, I am giving a short description of them. Uropod 1, peduncle with the usual triangular distal lobe, outer margin with five spines and inner margin with three longer spines; outer ramus with three spines on outer margin and none on inner margin; inner ramus with four spines on outer margin and none on inner margin. Uropod 2, peduncle with one distal spine on inner margin; rami without lateral spines. Uropod

3, ramus longer than peduncle and bearing long apical spines. Although the female has not been discovered the species is being placed in Section B1 for convenience.

Corophium insidiosum Crawford

Corophium insidiosum Crawford, Journ. Marine Biol. Assoc. United Kingdom, **21**(2): 615, fig. 2 *a-g*. 1937.

Corophium insidiosum Shoemaker, Journ. Washington Acad. Sci. **37**: 53, figs. 6, 7. 1947.

This species occurs on the east and west coasts of North America and on the west coast of South America. It has not yet been recorded from the east coast of South America. There are specimens in the U. S. National Museum collection from an islet off the pier at Talcahuano, Chile (about 37° S.); Oakland Estuary and Point Richmond, San Francisco Bay, Calif.; Oyster Bay, Totten Inlet, Puget Sound; and Greenbank Lake (brackish), Whidbey Island, Island County,

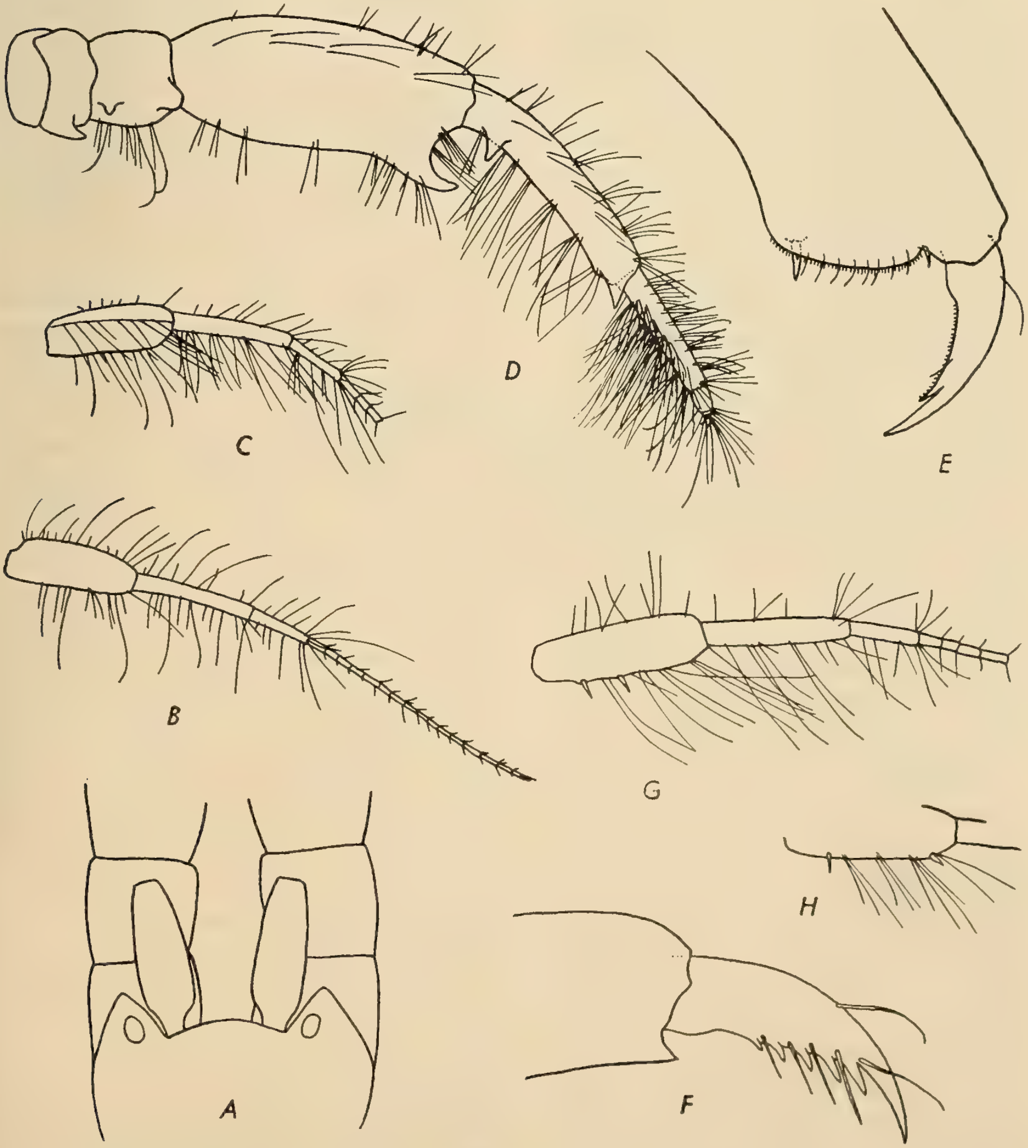

Fig. 6.—*Corophium spinicorne* Stimpson. Male: *a*, Front of head and antennae from above; *b*, right antenna 1 from above; *c*, right antenna 1, side view; *d*, left antenna 2, inside view; *e*, end of gnathopod 1 much enlarged; *f*, end of gnathopod 2 much enlarged. Female: *g*, Right antenna 1, side view; *h*, right antenna 1 of another specimen, side view.

Wash. Good males and females were taken in Greenbank Lake, which is the most northern locality for *C. insidiosum* on the west coast.

Corophium clarencense, n. sp.

Fig. 7

Corophium bonellii Shoemaker, Rep. Canadian Arctic Exped. 1913–18, **7**(E): 22. 1920.

Male.—Head with rostrum rather long and spear-shaped, somewhat expanded between the base and apex, curving downward very slightly, and reaching to about one-third the length of the first joint of antenna 1. Lateral lobes of head short and apically rounding; eyes dark and not very distinct. Antenna 1 reaching to about the middle of the fifth joint of antenna 2; first joint without any spines on inner margin, and without any protuberance on inner surface such as is present in the male of *C. insidiosum*, lower margin with one distal spine and one weaker spine near the middle; second joint a little shorter than the first; third joint not quite half as long as the second; flagellum about two-thirds as long as the peduncle and composed of seven joints. Antenna 2, second joint reaching very little beyond lateral lobes of head; third joint equal in length to first and second combined; fourth joint not greatly thickened, lower distal corner produced into a strong, slightly curved tooth above which is a smaller tooth, no spine on proximal lower inner surface such as shown by Stephensen for *C. uenoi* (Annot. Zool. Jap. **13**(5): 495, fig. 3A2. 1932); fifth joint rather slender and slightly curved, inner distal end produced into a blunt rounding lobe, and no vestige of a tooth or protuberance proximally on the lower margin; flagellum composed of one long and two short joints. Mandibular palp with first joint apically produced much as in *C. bonellii.*

Gnathopod 1, sixth joint with palm slightly oblique, evenly convex, passing into the hind margin of joint without lobe or angle, finely serrulate throughout, armed on outer edge with two or three submarginal spines, and defined by a stout spine; seventh joint considerably overlapping palm, inner margin finely serrulate and bearing a distal tooth. Gnathopod 2, seventh joint rather long and bearing one distal tooth on inner margin proximally to which is a row of three slender spinules and a row of very small blunt teeth. The uropods and telson are like those of the female. Length of male from front of head to end of uropods 4 mm.

Female.—Head, rostrum broadly triangular. Antenna 1, first joint with two spines proximally and several long setae distally on inner margin, three spines on lower margin; second joint about two-thirds as long as the first and twice as long as the third; flagellum as long as second and third peduncular joints combined, and composed of six or seven joints. Antenna 2 not very setose, gland-cone prominent and bearing two short apical spines; third joint with two distal spines on lower margin; lower margin of fourth joint with one distal spine, a pair of spines near the middle and a pair proximally; fifth joint with one spine near the middle of the lower margin; flagellum about as long as fifth peduncular joint and composed of one long joint and two very short distal joints. Mandibular palp with first joint produced distally and bearing the usual plumose seta. The palp of one of the mandibles of one of the females has two apical setae on the first joint as shown in Fig. 7, *h*. Gnathopod 1, sixth joint with palm oblique, finely pectinate throughout, armed on the outside with four submarginal spines and defined by a rather long stout spine; seventh joint when closed against the palm reaches to the long defining spine, inner margin finely pectinate and bearing a forward-pointing tooth distally. Gnathopod 2, seventh joint with one distal tooth, proximally to which are three slender spinules and fine serrations.

Uropod 1, peduncle with triangular distal lobe, outer margin with three or four spines on distal half and a row of several slender spinules on proximal half, inner margin with three spines on distal half; outer ramus with five spines on outer margin and none on inner margin; inner ramus with six spines on outer margin and none on inner margin. Uropod 2, outer margin of peduncle with one distal spine and three equally spaced slender spinules, inner margin with one distal spine; outer ramus with three spines on outer margin and none on inner margin; inner ramus with three spines on outer margin and none on inner margin. The outer ramus of right uropod 2 of the female figured has only two spines on outer margin, but three is probably the normal number. Uropod 3, peduncle with four long spinules on outer margin; ramus a little longer than peduncle and armed with long slender spinules on apex and outer margin. Length of female from front of head to end of uropods 4 mm.

Type.—A male taken at station 20b, Port Clarence, Grantley Harbor, Alaska, by the Cana-

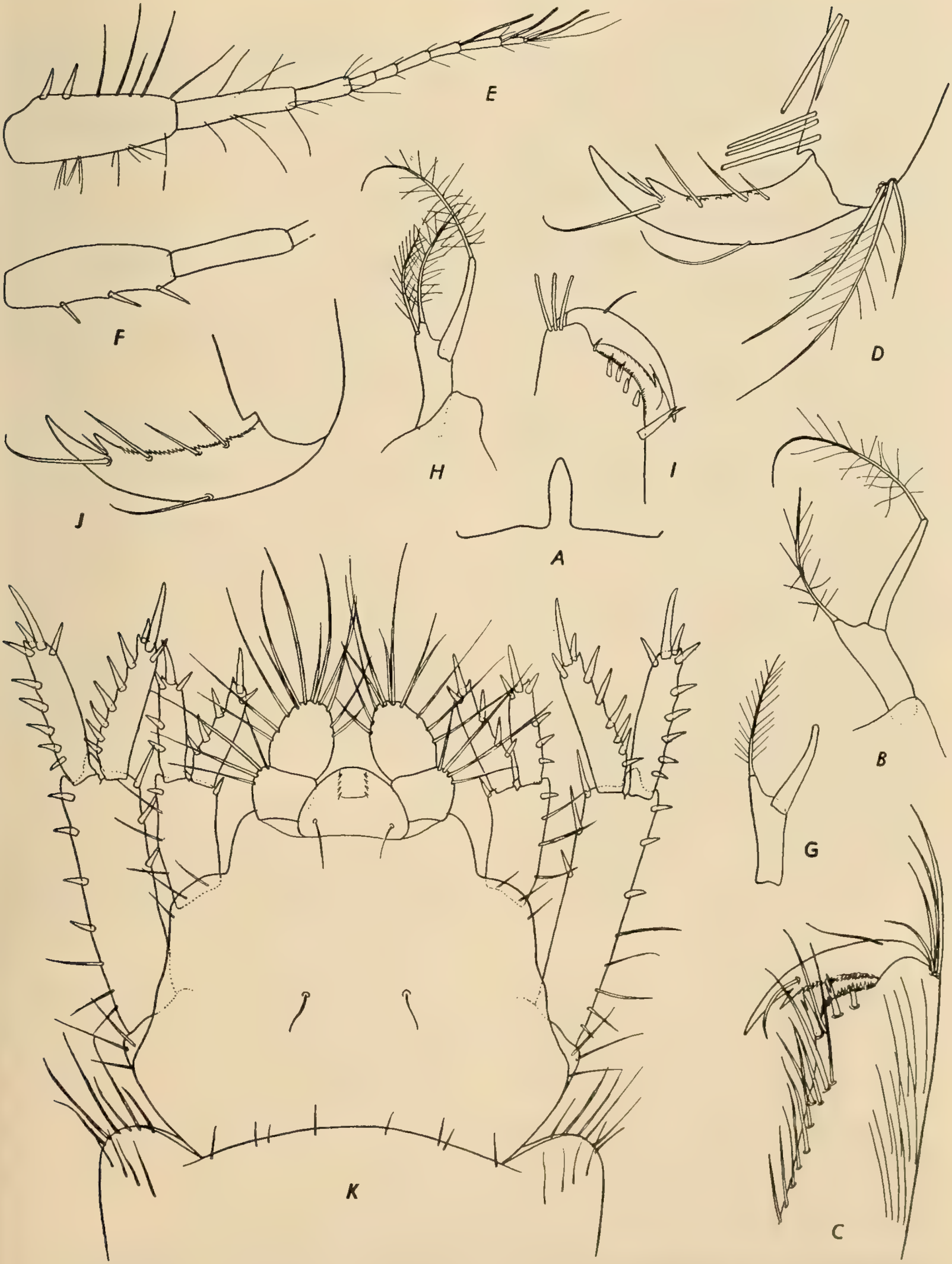

Fig. 7.—*Corophium clarencense*, n. sp. Male: *a*, Rostrum; *b*, mandibular palp; *c*, end of gnathopod 1; *d*, end of gnathopod 2. Female: *e*, Right antenna 1 from above; *f*, right antenna 1, side view; *g*, mandibular palp; *h*, mandibular palp with two plumose setae on first joint; *i*, end of gnathopod 1; *j*, end of gnathopod 2; *k*, urosome and uropods.

dian Arctic Expedition, July 30, 1913, in 2 to 3 fathoms, sandy mud with many algae. The type is in the Ottawa Museum, Ottawa, Canada.

Remarks.—One male and four females were taken at the type locality and were identified as *C. bonellii* (Milne-Edwards) in my Canadian Arctic Report. The male of *C. bonellii* had not been described, but as these females had many characters in common with the female of that species I concluded that the specimens belonged to *C. bonellii. C. bonellii, C. uenoi* Stephensen, *C. insidiosum* Crawford, and *C. clarencense* possess characters which appear to indicate close relationship. *C. clarencense*, however, possesses a combination of characters which distinguishes it from the other three. The male of *C. c.* has a long spear-shaped rostrum. The first joint of antenna 1 has no protuberance on the inner surface, no spines on inner margin and two spines on lower margin. The fourth joint of antenna 2 has no spines on lower margin or inner surface, and the fifth joint is without spine or protuberance on lower margin. The seventh joint of gnathopod 2 has only one tooth on inner margin. The first joint of the mandibular palp is strongly produced distally.

In the female, the head has a broad triangular rostrum. The first joint of antenna 1 has two spines on the inner margin and three spines on lower margin The fourth joint of antenna 2 has on the lower margin one distal spine and two pairs of spines proximally; and the fifth joint has one spine on lower margin. The seventh joint of gnathopod 2 has one tooth on inner margin.

Corophium oaklandense, n. sp.

Fig. 8

Fully developed specimens of this species possess a marsupium carrying eggs, and also possess fully developed external male sexual organs. It, therefore, appears that the species is hermaphroditic.

Description. — Head with well-developed acutely triangular rostrum. Eyes oval and dark reddish brown in alcoholic specimens. Antenna 1 reaching to the end of antenna 2; inner edge of first joint with a spine just beyond the apex of the rostrum, lower edge of joint with one distal spine, two spines at about the middle, and several long setae on the distal third; second joint over half the length of the first; and third joint half the length of the second; flagellum a little longer than second and third peduncular joints combined and consisting of about seven joints. Antenna 2, first, second and third joints combined nearly as long as fourth joint; third joint with two distal spines on lower margin; fourth joint with lower margin produced distally into a curved tooth above which is a smaller tooth, a pair of spines at distal third of lower margin and a group of three spines near the proximal third (Fig. 8, *d*); some specimens possess only one spine at distal third and two proximally (Fig. 8, *e*); fifth joint produced distally on the inside into a triangular lobe, lower margin may or may not bear a spine; flagellum short and composed of three joints.

Mandibular palp with first joint somewhat produced distally and bearing the customary plumose seta (the specimen figured possessed two setae, which is unusual); the second joint is articulated obliquely to the first and bears the customary plumose seta. Gnathopod 1, palm oblique, convex, finely dentate throughout, armed on the outside with seven submarginal spines, defined by a larger spine, and passing into the hind margin of joint by an evenly rounding curve; seventh joint fitting palm, inner margin finely dentate and bearing a forward-pointing distal tooth. Gnathopod 2, inner margin of seventh joint finely dentate and armed with three teeth, the proximal one being much smaller than the others.

Peraeopod 5 with second joint well expanded. Urosome slightly arched from side to side. Uropod 1, peduncle with the distal triangular lobe curving strongly toward the outer lateral margin; spinal armature of the uropods as shown by Fig. 8, *j*. Length from rostrum to end of uropod 1 about 5 mm.

All the specimens of *C. oaklandense* were taken by Miss Helen Gay from experimental blocks which she was using in studying the settling of marine organisms in Oakland Estuary, San Francisco Bay, Calif., in 1941.

Type.—U.S.N.M. no. 80522.

This species has been placed in Section B2 as the sexes are alike, though they are represented by the same individual.

It is interesting to note how the characters of both sexes appear to be combined in the second antenna: the fourth joint has the strong distal tooth of the male and the groups of spines usually confined to the female; and the fifth joint may or may not have the stout spine on the lower margin which is also a character confined to the female.

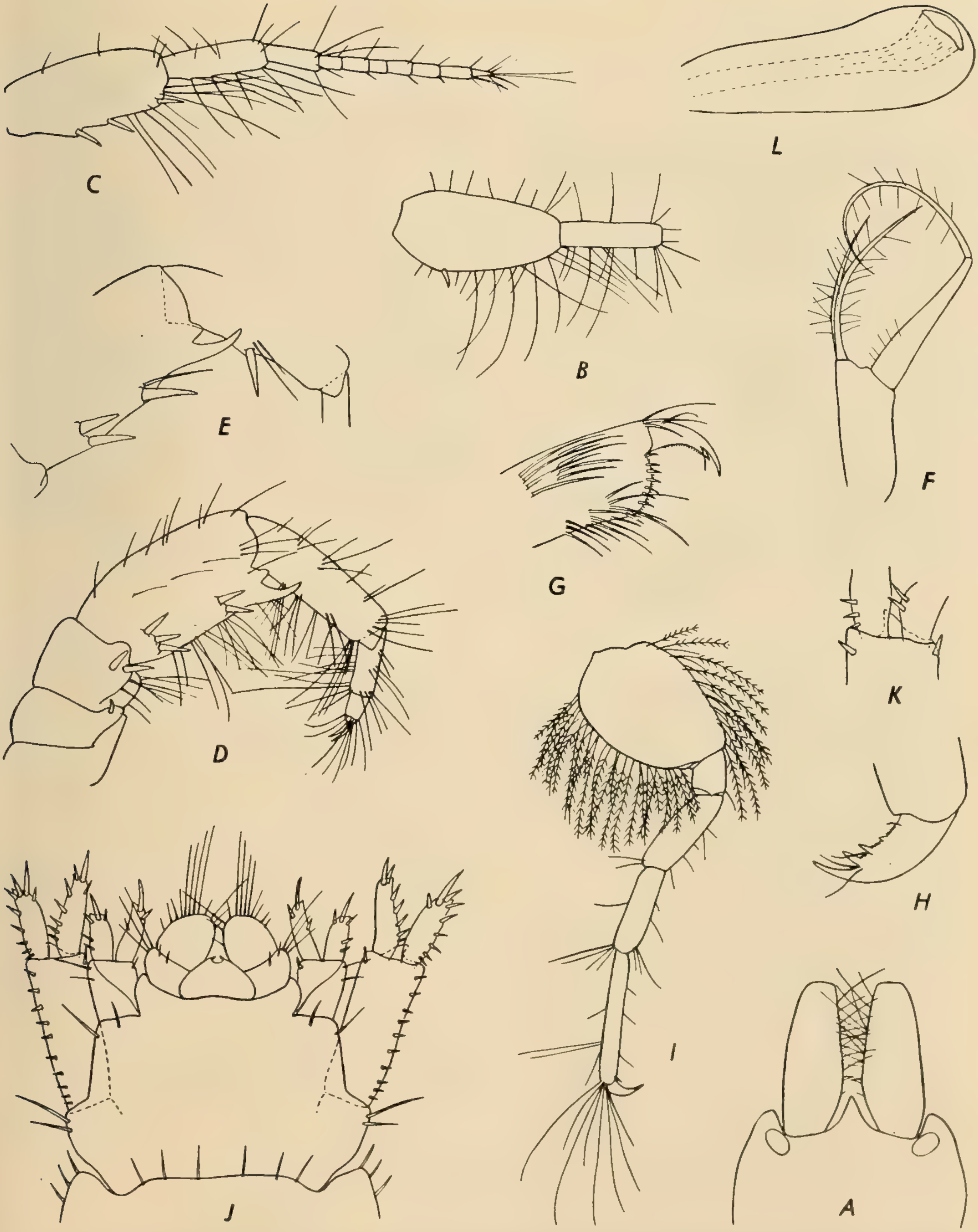

Fig. 8.—*Corophium oaklandense*, n. sp.: *a*, Dorsal view of head; *b*, left antenna 1 from above; *c*, left antenna 1, inside view; *d*, left antenna 2, inside surface; *e*, left antenna 2 of another specimen; *f*, mandibular palp showing two plumose setae on the first joint, which is unusual; *g*, end of gnathopod 1; *h*, end of gnathopod 2; *i*, peraeopod 5; *j*, urosome and uropods; *k*, uropod 1 showing distal lobe; *l*, external male sexual organ.

Corophium baconi Shoemaker

Fig. 5, *g, h*

Corophium baconi Shoemaker, Journ. Washington Acad. Sci. **24:** 356, fig. 1, 1934.

In the collection of the U. S. National Museum there are very fine specimens of this species taken in July 1935 in Newport Bay, Orange County, Calif., by G. E. MacGinitie. Among them are many fine mature males and females, which are much larger than those from Peru used for the original description and figures. The females, though larger, are like those from Peru, but the males show some characters of the second antenna which differ somewhat from those of the Peruvian specimens. These differences, however, appear to be due only to the greater maturity of the specimens. The fourth joint of the second antenna of the male bears proximally on the lower inner side a ridge or keel provided with two small spines; the small distal tooth of this joint points directly forward, but the large tooth is curved horizontally inward toward the axis of the body so that when the second antennae lie parallel these large teeth cross each other. The fifth joint of the second antenna is without a proximal tooth, but has a stout downward-curving tooth on the inner surface near the distal end. The first antenna, gnathopods, and urosome are as described and figured for the Peruvian specimens. The largest males measure about 3 mm from rostrum to end of uropods. The largest females measure 4 mm.

Corophium baconi has been recorded from the following localities: Off Paita, Peru; Salinas Bay, Costa Rica; La Jolla, Corona Del Mar, Newport Bay, San Pedro, Venice, and Santa Monica, Calif.; and *Albatross* station 3253, which is in Bering Sea. It is a long gap from Santa Monica to Bering Sea, but the *Albatross* specimen is a fully developed male of this species.

PROCEEDINGS OF THE ACADEMY

422d MEETING OF BOARD OF MANAGERS

The 422d meeting of the Board of Managers, held in the Cosmos Club, November 15, 1948, was called to order at 8:05 p.m. by the President, Dr. F. D. ROSSINI. Others present were: H. S. RAPPLEYE, N. R. SMITH, J. I. HOFFMAN, W. W. DIEHL, W. N. FENTON, WALTER RAMBERG, T. D. STEWART, W. A. DAYTON, C. A. BETTS, F. B. SILSBEE, M. A. MASON, L. A. ROGERS, H. G. DORSEY, O. B. FRENCH, C. L. GAZIN, and, by invitation, H. E. MCCOMB, R. J. SEEGER, and F. H. H. ROBERTS, JR.

The Secretary read a report of the Senior Editor, Dr. J. I. HOFFMAN, on bids received for the printing of the JOURNAL. The Executive Committee met informally and was unanimous in recommending to the Board that the bid offered by the Waverly Press, of Baltimore, be accepted. The Board accepted the recommendation and authorized the Senior Editor to contract with the Waverly Press for the printing of the JOURNAL.

The chairman of the Committee on Meetings, Dr. RAYMOND J. SEEGER, reported the change in program at the last meeting of the Academy necessitated by Dr. TRYTTEN's illness. As a result, Dr. ALEXANDER WETMORE spoke on the work of the Interdepartmental Committee on Scientific Research and Development; Dr. C. J. LAPP, deputy chief of the Office of Scientific Personnel, spoke on baccalaureate origins of doctorates in scientific work; and Dr. B. D. VANEVERA spoke on the fellowship program of the National Research Council. Dr. SEEGER also announced that Dr. BACHER of the Atomic Energy Commission would speak on atomic-energy research at the November meeting, and that the December meeting would be devoted to a symposium on cancer research. Three speakers had been secured for the latter topic, including Dr. R. R. SPENCER, of the National Cancer Institute, who would talk on *Causes*; Dr. H. F. DORN, also of the National Cancer Institute, who would talk on *Incidence and distribution*; and Dr. C. T. KLOPP, of the Warwick Clinic of George Washington University Hospital, who would talk on *Detection and treatment*. Dr. SEEGER mentioned also that the committee was considering plans for the January Annual Meeting dinner.

The chairman of the Committee on Membership, H. E. MCCOMB, presented 17 nominations for resident membership and 1 nomination for nonresident.

The chairman of the Special Committee on Bylaws, Dr. WALTER RAMBERG, presented the following committee report on changes in the Standing Rules:

> The Committee recommends the following revisions of the Standing Rules of the Board of

Managers in order to carry out the recommendations of the report of the Committee on Policy and Functions which was accepted by the Board on September 27, 1948, and of the report of the Committee on Encouragement of Science Talent which was accepted on October 18, 1948:

Standing Rules

Section 3, replace by

There shall be eight STANDING COMMITTEES, as follows: Executive Committee, Committee on Meetings, Committee on Membership, Committee on Monographs, Committee on Awards for Scientific Achievement, Committee on Grants-in-Aid for Research, Committee on Policy and Planning, Committee on Encouragement of Science Talent. Two members of the Board shall be appointed to serve on the Executive Committee. The Committee on Membership, Meetings, Grants-in-Aid for Research, and each of the Subcommittees of the Committee on Awards for Scientific Achievement shall include, if possible, at least two members reappointed from the preceding year. The Committee on Monographs, The Committee on Policy and Planning, and the Committee on Encouragement of Science Talent shall have six members, each appointed for three years at the rate of two each year. Two members of the Committee on Monographs and two members of the Committee on Policy and Planning shall be past editors of the JOURNAL, if possible. All appointments shall be for one year unless otherwise specified, and shall be made by the President, who shall announce them at the first meeting of the Board following the annual meeting.

Section 10, replace by

The COMMITTEE ON POLICY AND PLANNING shall periodically assess the status of the Academy from a point of view of long term objectives and shall recommend to the Board any changes in policy or in long range planning designed to make the Academy more effective in the scientific life of Washington.

Section 11, replace by

The COMMITTEE ON ENCOURAGEMENT OF SCIENCE TALENT shall give consideration to and make arrangements for participation of the Washington Academy in activities promoting a professional interest in science among people of high school and college age.

Sections 10 to 15

Renumber 12 to 17.

WALTER RAMBERG, *Chairman.*
C. L. GAZIN.
NATHAN R. SMITH.

The Board accepted the report of the Committee, and, inasmuch as the changes had been announced at an earlier meeting of the Board, their acceptance at this meeting constituted final approval.

The chairman of the Special Committee on the Index to the Journal, Dr. W. N. FENTON, announced that Miss MARY A. BRADLEY, technical editor for the Bureau of Entomology and Plant Quarantine, had submitted a bid of $1,500 for indexing the first 40 volumes of the JOURNAL and asked Board approval to proceed in the matter. The Board authorized Dr. FENTON to secure the services of Miss BRADLEY for the above purpose, the cost to be paid from the $2,000 set aside for this purpose and as prescribed by the Board at its 419th meeting.

Miss CHARLOTTE ELLIOTT was transferred to the retired list of members, effective December 31, 1948.

The Secretary announced that the District of Columbia Section of the American Society of Civil Engineers had pledged $5 toward the Science Calendar. In addition, Messrs. SMITH, RAMBERG, and BETTS announced that the Bacteriological, Philosophical, and Engineering Societies would notify the Secretary shortly of their contributions to this fund.

The Secretary read a letter from H. H. BARTLETT, of the University of Michigan, recommending the election of more honorary members from foreign countries.

The Board decided to refer the subject of this letter to the forthcoming Committee on Policy and Planning for their recommendations, which, it is expected, will serve to guide the Membership Committee in any undertaking which may be proposed along these lines.

The meeting was adjourned at 9:40 P.M.

C. LEWIS GAZIN, *Secretary.*

423D MEETING OF BOARD OF MANAGERS

The 423d meeting of the Board of Managers, held in the Cosmos Club, December 13, 1948, was called to order at 8:05 p.m. by the President, Dr. F. D. ROSSINI. Others present were: H. S. RAPPLEYE, N. R. SMITH, J. I. HOFFMAN, F. M. DEFANDORF, WALTER RAMBERG, W. W. RUBEY, W. A. DAYTON, A. O. FOSTER, L. A. ROGERS, C. L. GARNER, O. B. FRENCH, C. L. GAZIN, and, by invitation, R. J. SEEGER, ALAN STONE, L. V. JUDSON, F. H. H. ROBERTS, Jr., and F. THONE.

The President announced that, in consultation with the nominee for President in 1949, the following new Standing Committee had been appointed in advance of the coming Academy year: *Committee on Encouragement of Science Talent:* M. A. MASON, Chairman, and A. T. MCPHERSON, to January 1952; B. D. VANEVERA and FRANK THONE, to January 1951; E. H. WALKER and L. B. TUCKERMAN, to January 1950.

Dr. FRANK THONE, representing the Meetings

Committee, announced a change in one of the speakers originally scheduled for the December meeting, which is to be in the form of a symposium on Cancer Research. Owing to a misunderstanding as to the date of the meeting, Dr. WALTER S. HARRISON was secured to substitute for Dr. CALVIN T. KLOPP on the subject of *Detection and treatment.*

Dr. R. J. SEEGER, chairman of the Committee, announced that inasmuch as the Cosmos Club could not handle over 35 for the annual dinner in January, the Committee was making arrangements to hold the dinner at Hotel 2400. On a motion by Mr. DAYTON, the Board reaffirmed its intention to hold the annual dinner and agreed that the details of the annual meeting be left to the discretion of the Meetings Committee.

The chairman of the Committee on Monographs, Dr. L. V. JUDSON, announced that the monograph on *The parasitic cuckoos of Africa*, by Dr. HERBERT FRIEDMANN, was going to press, according to last reports, and that Dr. REHDER was attending to plans for publicity.

Seventeen persons were elected to resident membership and one to nonresident.

WALTER D. LAMBERT was transferred to the retired list of members, effective December 31, 1948.

The resignation of Dr. ROBERT F. GRIGGS was accepted, with regret, effective December 31, 1948.

The Secretary announced that the American Society of Bacteriologists and the Washington Section of the A.I.E.E. had agreed to contribute $5 each to the fund for the Science Calendar. The Biological Society had agreed to contribute $10 and the Entomological Society $2.50. The Medical Society notified the Secretary that no funds were available for this purpose.

The Senior Editor, Dr. JAMES I. HOFFMAN, announced that arrangements for printing of the JOURNAL by the Waverly Press were under way and that informal agreements had been reached.

Dr. THONE presented the Board with Tax Exempt Status forms of the Bureau of Internal Revenue to be filled out and filed to assure recognition of the tax-exempt status of the Washington Academy of Sciences. The Board referred the matter to the Treasurer for such action as may be required.

The meeting was adjourned at 9:15 P.M.

C. LEWIS GAZIN, *Secretary.*

ACADEMY'S MONOGRAPH NO. 1 PUBLISHED

The first number in the Washington Academy of Sciences Monograph Sereis was published on January 22, 1949. It is entitled *The parasitic cuckoos of Africa.* The author is Dr. Herbert Friedmann, the eminent curator of the Division of Birds in the U. S. National Museum, Smithsonian Institution.

The book presents a complete account of our knowledge of the 15 species of African parasitic cuckoos, based on the author's personal field work, on his many years' correspondence with ornithological observers in various parts of Africa, and on all the pertinent published data. Although forming a distinct unit by itself, the volume is a sequel to Dr. Friedmann's book on the parasitic birds of the Americas—the cowbirds—published 20 years ago. It includes much new factual information, and the results of prolonged and leisurely study and reflection, bearing on the problems inherent in the biology of reproductive parasitism in birds.

Besides his works on avian parasitism, on which subject he is a world authority, Dr. Friedmann is the author of *Birds of Ethiopia and Kenya Colony* (2 vols.); 2 volumes of Ridgway's monumental *Birds of North and Middle America; The symbolic goldfinch*, a scholarly work in the field of art history; and scores of papers in scientific journals. In 1940 he received the Academy's Award for Scientific Achievement in the Biological Sciences. He has been curator of birds in the National Museum since 1929, prior to which he taught biology at Brown University and Amherst College.

The Academy hopes to publish other monographs in this series as funds and suitable manuscripts are available. The present number, aggregating xii + 204 pages (with 10 halftone plates), is priced at $4.50 and may be ordered from Dr. Harald A. Rehder, U. S. National Museum, Washington 25, D. C.

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Vol. 39 March 15, 1949 No. 3

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This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) Short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued monthly, on the fifteenth of each month. Volumes correspond to calendar years.

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JOURNAL
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VOLUME 39 MARCH 15, 1949 No. 3

ARCHEOLOGY.—*Early flint horizons on the north Bering Sea coast.*[1] J. L. GIDDINGS, JR., University of Alaska. (Communicated by HENRY B. COLLINS.)

The tracing of Eskimos backward in time appears to have reached that inevitable stage where frost-preserved organic materials can no longer be counted upon to supplement stonework. In this announcement of an early flint site in the focal north Bering Sea area, we shall have to forego such excellent and traditional comparative traits as harpoon heads and styles of engraving in ivory and bone, mainly for styles in flaking.

In the course of a search for sound timbers for tree-ring dating in frozen early ruins,[2] extensive excavations were made last summer in two large sites at Cape Denbigh.[3] Underlying the frozen bulk of one of these typical Eskimo middens were found certain culture layers in clays almost wholly lacking organic remains. These clay layers are the subject of this preliminary report. The sites as a whole will be considered here only as much as background demands.

Cape Denbigh is a 10-mile-long basaltic ridge that parallels the shoreline of Norton Sound and is joined to the mainland by a broad neck of flat, low-lying swampland. Steep cliffs line most of the seaward edge of the cape, offering few favorable sites for camps or settlements. The two old sites investigated during the summer, Nukleet and Iyatayet, are both located on slopes well above the water's edge, and only Iyatayet has a constant source of drinking water. Both of these are legendary villages to the Shaktoolik Eskimos and are further marked as sites by their thick covering of bunchgrass, which contrasts with surrounding thickets of alder and nearby tundra slopes. Nukleet, visited by Collins in 1929[4], is an extensive mound that sprawls along slopes above a 70-foot cliff at a favorite sealing point on the south side of the Cape. Excavations of 1948 show that its depth of culture deposit ranges from 2 or 3 feet, in loosely consolidated material at the upper edge, to a maximum of 7 feet in stratified midden near the cliff edge. Preliminary analysis suggests final abandonment of the site in the early seventeenth century, with major periods of building immediately before that and much earlier. The bulk of the earlier period corresponds closely to Early Punuk[5] times on St. Lawrence Island. These conclusions are based on a clear cross-relation of certain traits with those of sites on St. Lawrence Island and in other parts of north Alaska; but a strong local cast, perhaps slanted toward the forested inland areas prevails in Nukleet from early to late. The inland influence is shown, among other traits, in bone counts, which indicate consistently high dependence on caribou; in the use of beaver teeth hafted both as end and side blades as the principal whittling tool; and in the use of birch-bark containers. The mound is solidly frozen beneath a maximum summer thaw of about 2 feet, and offers excellent preservation in such perishables as wood, textile, and skin. Some 200

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[1] Received January 3, 1949.

[2] A continuation of a long-range problem last summarized in Giddings, 1948.

[3] This investigation was sponsored by the Arctic Institute of North America in cooperation with the Office of Naval Research, and originated from the University of Alaska. This is part of a program jointly planned with Helge Larsen, curator of the Danish National Museum, whose party worked last season in Bristol Bay. Students and graduates of the University who took part in the field work are S. J. Newcomb, Wendell Oswalt, and Walter Arron.

[4] Collins, 1946, p. 51.

[5] See Collins, 1937; Geist and Rainey, 1936.

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samples of building timbers secured for tree-ring dating will be the means of attempting to date culture levels.

Iyatayet site, about 10 miles by water from Nukleet on the north side of the cape, is located on opposite, steep slopes at the mouth of a small but permanent stream. Interest in this site was increased by the presence of many flint chips in shallow tests made at the beginning of the field season. The significance of these chips became apparent, however, only after we had penetrated well into the Nukleet mound. At Nukleet, flint was extremely scarce; evidence of flaking was confined to an occasional crude drill bit and scraper, and a few rejected chips. On the assumption that Iyatayet flaking indicated a site earlier than Nukleet, eight test cuts were laid out and thawing was begun in this new location.

The many chips and implements of flinty material included in the upper layers at Iyatayet were puzzling at first, since it was clear from other artifacts that these deposits were closely related otherwise to middle layers at Nukleet. This anomalous condition was explained only after the discovery of an abundance of such flints concentrated in clay layers below this part of the midden. It appears that the later people to occupy the site had thoroughly mixed the earlier deposits with their own, presumably in digging pits for houses.

Both slopes at Iyatayet are covered with culture deposits containing organic matter in a good state of preservation which vary in depth from 2 to 6 feet. Most of these deposits are frozen, though they do not rest on permafrost (deeply frozen ground), as is the case at Nukleet. The greater occupation of this part of the site seems to have fallen in an Early Punuk period. A later occupation, represented by at least two house pits which are visible from the surface, is more closely related to Western Thule sites of northern Alaska.[6] In some of the tests, a grass level was clearly defined under the well-preserved material.[7] Below this lay clays frozen only in spots.

The clay base was barren on the west slope of the site, but on the east slope it held 1 to 3 feet of culture deposit. In these clay layers the only remains of an organic nature were lenses of charcoal and paperlike remains of mussel shells and an occasional trace of animal bone. The bones that could be identified as such were usually only brown stains in the clay. In those tests that were on steep slopes no clear stratification was found—a gradual soil creep down these slopes seems to have thoroughly mixed the clay deposits—but the clays are stratified on fairly level ground on a bench 40 to 50 feet above sea level. The clearest of this stratigraphy lay under the floor of house 1.

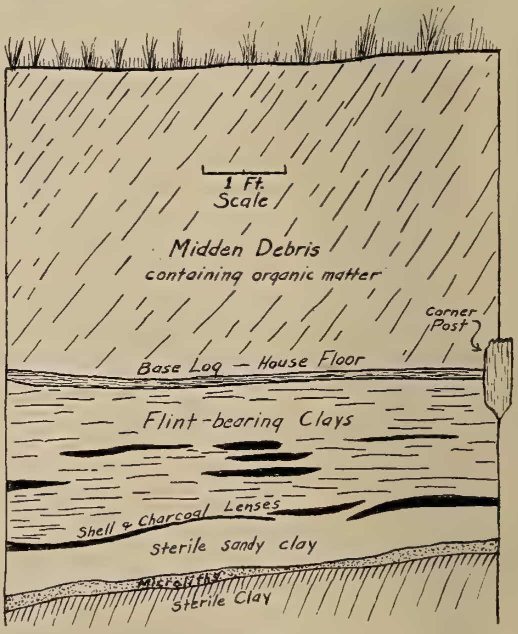

Fig. 1.—Section through north wall of house 1, Iyatayet site.

House 1 perhaps belongs to the period of last occupation of the site. It was a large, rectangular house, 15 by 17 feet in floor plan; and its tunnel opened into the house one-third of the distance from front to rear wall, directly in front of a large fireplace. The house had been floored with split logs and planks laid directly on the clay base of its excavated pit. At the rear of the house floor, the underlying clays were undisturbed. Here was found a clear separation of at least two periods of the clay culture deposits. (Fig. 1.)

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[6] Collins, 1940, pp. 561–2; Giddings, 1944, pp. 127–130.

[7] Elsewhere the old sod line was missing, presumably because of subsurface digging at the beginning of this stage of the deposits.

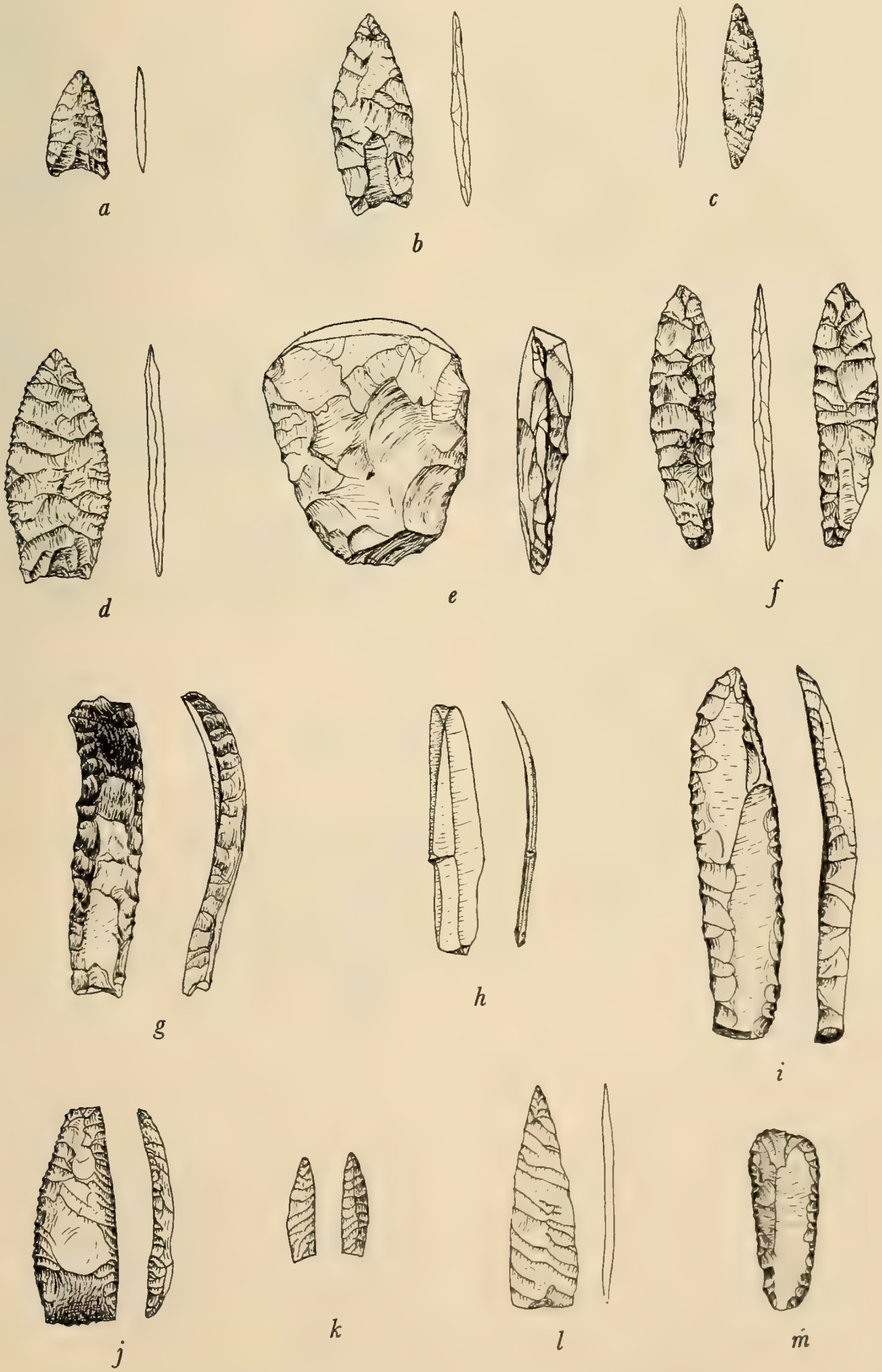

Fig. 2.—Flints, Iyatayet clay layers and microlithic layer. (*j-l*, natural size; all others four-fifths natural size.)

UPPER CLAY LAYERS

The flints and associated stone artifacts held in the upper 1½ to 2 feet of these clays appear to represent more than one period of culture, but stratification is inconclusive. Some traits that characterize these layers are the following: (1) Thin, hard, sand-tempered pottery, the outer surface of which is completely covered with either minute check-stamps or vertical striations (Fig. 4); (2) thin end blades and side blades of chert, jasper, and chalcedony in a range of types paralleling those reported from the Ipiutak site at Point Hope[8] (Fig. 2, *b*, *c*, *f*); (3) variants of the above forms of end blades and side blades, including some with serrate edges (Fig. 2, *d*); (4) flaked, thin end blades of silicified slate, sometimes ground along the center of a face; (5) short knife (?) blades of flinty material with one broadly convex edge (Fig. 3, *c*); (6) ovate adz blades flaked from silicified slate and ground to a blade at the narrow edge (Fig. 3, *b*); (7) a variety of end and side scrapers, including thin retouched flakes and carefully executed double-convex types (Fig. 3, *e*, *f*); (8) large, flaked, semilunar blades of silicified slate (Fig. 3, *g*); (9) very small, thin sharpeners (?) of shale, rectangular in cross section, and grooved on one or more surfaces; and (10) possibly the stone lamps described below.

The end blades of silicified slate seem to be more numerous near the top of the clays. These are not so closely related to Ipiutak types as are those of chert, etc., many of them having strongly concave bases. Some of these appear closely related to Dorset types (Fig. 2, *a*).[9]

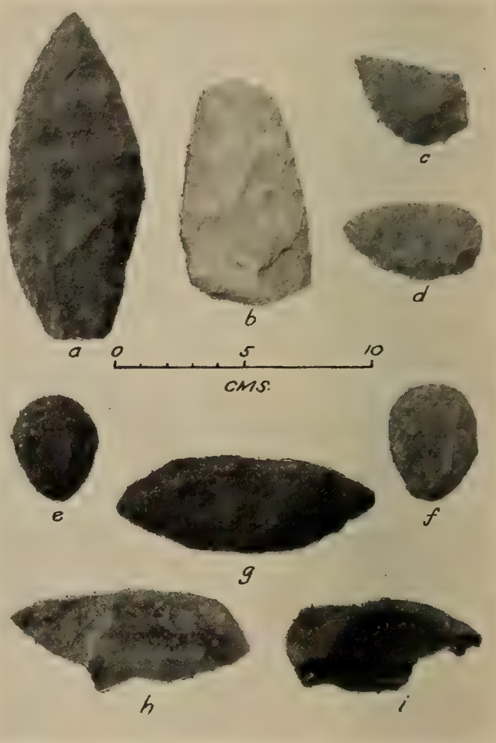

Fig. 3.—Objects of silicified slate and pecked stone, Iyatayet, mainly upper clay layers: *a*, Large blade with three-quarters of the blade retouched; *b*, ovate adz blade, ground at small end; *c*, knife (?) blade with one broadly convex edge; *d*, knife blade; *e*, *f*, double-convex end scrapers; *g*, semilunar blade; *h*, fragment of vessel and shallow pecked basin; *i*, fragment of lamp or mortar with hemispherical basin pecked in granitic boulder.

Check-stamped potsherds greatly outnumber striated sherds. A rocker stamp may have been used, rather than a paddle, as shown particularly in checking on the concave base of one vessel. Vessels were uniformly small; they included only cooking pots; and they had both round and flat (or concave) bases. Sand appears to be the only temper. If later detailed examination confirms the absence of feathers, grass or hair, this will prove a strong point of difference between this and Eskimo pottery in general.

MICROLITHIC LAYER

Below the culture layers just considered lay sterile sandy clay, 2 to 6 inches in depth, and below that was a thin, gravelly layer containing a large number of lamellar flakes (Fig. 2, *h*), and derivatives of such flakes. Retouched lamellar flakes include leaf-thin end blades (Fig. 2, *l*), side blades (Fig. 2, *k*), and a variety of scrapers or knives (Fig. 2, *g*, *i*, *j*). Some of the flakes show signs of use without further preparation. We found none of the prepared cores from which lamellar flakes were struck, but the plain or retouched lamellar flakes themselves make up more than half of the complete and fragmentary objects here found.

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[8] This and following references to the Ipiutak site are based on Rainey, 1941a and 1941b, and on examination of specimens in the University of Alaska collections. Unfortunately, the comprehensive report recently completed by Helge Larsen and Froelich Rainey is not yet received.

[9] See especially Wintemberg, 1939, pl. 6, fig. 2, *5–11*.

This level is distinguished by: (1) Lamellar flaking as a major industry; (2) diagonal retouching of these flakes with almost microscopic precision; (3) flaking of chert, jasper, and much obsidian, to the exclusion of coarser materials; (4) very small ovate and obovate end scrapers (Fig. 2, *m*); (5) arrowshaft smoothers (?) of grooved sandstone; (6) absence of ground slate; and (7) absence of pottery.

Fragments of large blades, and whole and fragmentary side scrapers, all of chert and related materials, also come from this level. Only one object has been ground. This is an obovate piece of highly silicified metamorphic rock, which fractures like chert; it is carefully retouched on both convex faces and then ground to a strong bevel at the broad end (Fig. 2, *l*). If it is the blade of a composite-headed adz, as the beveled edge suggests, it appears unique among Alaskan adz blades. A type of small lamp (or mortar?) has a cup-sized, hemispherical bowl pecked and smoothed in a small stream boulder of metamorphic or igneous rock (Fig. 3, *i*). Five of these are represented, all but one from unstratified sidehill tests. The only whole specimen was found on top of the microlithic layer under house 1, indicating that the type is associated with this earliest level.

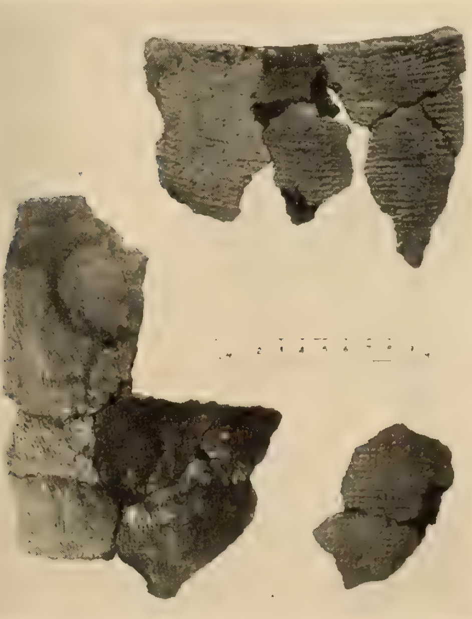

Fig. 4.—Check-stamped and striated pottery. Iyatayet upper clay layers.

EVALUATION

The Cape Denbigh sites offer a remarkable stratigraphic sequence which, when further explored and analyzed, will show regional changes in Eskimo culture through a long time span and perhaps will help explain the cultural base out of which developed more than one North American culture. There seems to be no doubt of a close relation of certain flint types and techniques in the upper clay layers at Iyatayet to those of Ipiutak. The absence of pottery at Ipiutak is to be considered, however. That the Iyatayet microlithic layer is older than Ipiutak is to be inferred from the lack of development of lamellar flaking in the Point Hope site.[10] Types from the Iyatayet clays are, in the main, unlike those of Dorset culture, but a degree of similarity exists between these two cultures as shown particularly in prevalence of lamellar flaking.[11] The presence of much lamellar flaking and a type of very small end scraper at Iyatayet and in such distant inland localities as Fairbanks, in central Alaska,[12] Kluane Lake in the Canadian Yukon Territory,[13] and the Gobi Desert in Mongolia,[14] is an interesting point of speculation. Whatever the interrelations of early far-northern horizons, it is likely that these must finally be traced mainly in terms of work in stone.

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[10] The lamellar flake and its parent core are reported as sporadic and minor traits in other Eskimo and inland Alaska sites of various ages. See summary in de Laguna, 1947, pp. 171–172; also Giddings, 1944, p. 121.

[11] Leechman, 1943, pp. 370–371; Wintemberg, 1939, p. 90.

[12] Rainey, 1939, pp. 387–388.

[13] Johnson, 1946, pp. 183–186.

[14] Nelson, 1937, pp. 267–272.

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PALEONTOLOGY.—*New Kansas Lower Cretaceous Foraminifera.*[1]

ALFRED R. LOEBLICH, JR., and HELEN TAPPAN, U. S. National Museum. (Communicated by JAMES S. WILLIAMS.)

The writers have in press a paper describing the foraminiferal fauna of the type Kiowa shale of Kansas. As some of the species are also mentioned in another paper in press, which will have prior publication, descriptions of two of the new species and a new generic diagnosis are given here. This is being done in order to validate the names so that they will not appear as nomina nuda.

Genus **Ammobaculites** Cushman

Ammobaculites euides Loeblich and Tappan, n. sp.

Test free, medium in size, early portion coiled, later uniserial, rounded in section; about four chambers in the involute coil, later portion with as many as six uniserial chambers; sutures somewhat obscure in the coil; straight and depressed in the later portion; wall finely arenaceous, surface smoothly finished; aperture terminal, rounded. Length of holotype 0.96 mm., greatest breadth 0.35 mm., greatest thickness 0.19 mm.

Remarks.—A complete series can be obtained of this species, from specimens with only the early coil to specimens with as many as six uniserial chambers. This species differs from *A. coprolithiformis* (Schwager) in being about one-third smaller with specimens of equal development, and in having an initial coil of diameter greater than that of the uniserial portion. In *A. coprolithiformis* the earliest uniserial chambers are much narrower than the coil, the test then flaring with growth, and the chambers also increasing rapidly in height as added. In *A. euides* the initial coil is greater in diameter than the uniserial portion, which increases very little in diameter or chamber height. *Ammobaculites euides* is similar to Upper Cretaceous specimens referred to *A. coprolithiformis* by Cushman, but differs from these in the smaller size, in having comparatively higher chambers, and in having a much more smoothly finished wall.

Occurrence.—The holotype of this species was collected from the Kiowa shale, along the south bluff of the Medicine Lodge River, in the E½ sec. 16, T. 30 S., R. 17 W., Kiowa County, Kans. The species is found also in the Kiowa shale ("Spring Creek" clay) from Spring Draw, in the SE¼ sec. 4, and E½ sec. 3, T. 30 S., R. 18 W., and from the draw in the SE¼ sec. 9, T. 30 S., R. 16 W., Kiowa County, Kans.

Types.—Holotype, U. S. N. M. No. 112528; paratypes, U. S. N. M. No. 112527a–d and University of Kansas collections.

Ammobaculites obliquus Loeblich an Tappan, n. sp.

Test free, medium in size, early portion close coiled, later uniserial and rounded in section; five to seven chambers in the coil, followed by three to four uniserial chambers; sutures straight and obscure in the coil, oblique and slightly depressed in the uniserial portion; wall finely arenaceous, surface smoothly finished; aperture terminal, rounded. Length of holotype 0.86

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received February 2, 1949.

mm, greatest breadth 0.32 mm, greatest thickness 0.25 mm.

Remarks.—This species differs from *Ammobaculites coprolithiformis* (Schwager) in being about one-half as large, in having a more compressed coil, and in possessing oblique sutures in the uniserial portion.

Occurrence.—The holotype is from the Kiowa shale along the south bluff of the Medicine Lodge River in the E½ sec. 16, T. 30 S., R. 17 W., Kiowa County, Kans. It is recorded also from the Kiowa shale in the draw in the SE¼ sec. 9, T. 30 S., R. 16 W., and from the Kiowa shale ("Spring Creek" clay) in Spring Draw, in the SE¼ sec. 4 and E½ sec. 3, T. 30 S., R. 18 W., Kiowa County, Kansas.

Types.—Holotype, U. S. N. M. no. 112522; paratypes, U. S. N. M. no. 112521a–c and University of Kansas collections.

Verneuilinoides Loeblich and Tappan, n. gen.

Diagnosis.—Test free, elongate, triserial throughout, with rounded angles, chambers increasing in size toward the apertural end; sutures generally distinct and depressed; wall arenaceous, aperture an arch at the base of the final chamber.

Genotype.—*Verneuilina schizea* Cushman and Alexander (1930: 9)

Remarks.—This genus differs from *Verneuilina* d'Orbigny in having rounded angles, rather than being triangular in section, and in being elongate and narrow rather than pyramidal in shape. The genotype of *Verneuilina*, *V. tricarinata* d'Orbigny, has a definite pyramidal test, with sharp angles; thus the rounded forms must have a new name. The following previously described species are here referred to *Verneuilinoides: Verneuilina fava* Bartenstein (1937: 183) (Dogger), Jurassic of Germany; *V. schizea* Cushman and Alexander (1930: 9) (Goodland), Lower Cretaceous of Texas; *V. polystropha* (Reuss) (1846: 109) is questionably referred to *Verneuilinoides*. This species was described by Reuss from the Upper Cretaceous of Bohemia as *Bulimina polystropha* with the statement that it had a "very rough surface" although he did not state the wall composition. It was later referred to *Verneuilina* by Parker, Jones, and Brady, and arenaceous forms were so identified by these workers as well as Cushman and Jarvis. Reuss' illustrations do not show the arenaceous character, but as they are somewhat diagrammatic this is not conclusive. Cushman stated that there were no specimens of the species in any of the Reuss collections in Vienna, Dresden, or Cambridge and that he had been able to find none in material from the type locality. Thus it can not be definitely determined whether or not the original material was calcareous or arenaceous. Specimens were referred to *Bulimina polystropha* by Berthelin (1880: 30) from the Albien of Moncley, France, with the statement that the species had a hyaline test, very distinctly perforate. Chapman (1892: 756) recorded *Bulimina polystropha* from the Gault of Folkestone stating, "In the Gault are innumerable examples of a tiny vitreous-shelled Foraminifer, which appears more closely related to Reuss's specimen from the Bohemian chalk . . . than to the recent forms with a sandy test, described under the name of *Verneuilina polystropha* (Parker, Jones, and Brady). The Gault specimens have an abnormal *Bulimine* oral aperture, somewhat semicircular in outline, but their relation to the *Buliminae* appear to be established by the presence of some fine radiating striae round the aperture. This very minute form is one of the smallest in the Gault series, and found only in the finest siftings. . ." Thus both Berthelin and Chapman state that the specimens were calcareous. In addition to the differences in wall character, the Lower Cretaceous specimens of Berthelin and Chapman are much smaller than the Upper Cretaceous form, and the chambers are higher and more globular. Thus the Lower Cretaceous specimens are quite distinct from the arenaceous forms, and probably belong to either *Gumbelitria* or *Bulimina*, the globular chambers and large rounded aperture suggesting the former, although the striations around the aperture mentioned by Berthelin and Chapman suggest a relationship with the Buliminidae. The Upper Cretaceous references to the species other than the original one seem to belong definitely to *Verneuilinoides*, but as the original material is questionable, it does not seem advisable to refer them to Reuss' species. According to Cushman, the Recent references to the species should be placed in *Verneuilina scabra* (Williamson) or in *V. advena* Cushman.

Additional species placed in *Verneuilinoides* are *Verneuilina kurti* Jennings (1936: 12) (Navesink marl), Upper Cretaceous of New Jersey; *V. perplexa* Loeblich (1946: 138) (Pepper formation), Upper Cretaceous of Texas; *V. bearpawensis* Wickenden (1932: 87) (Bearpaw shale), Upper Cretaceous of Canada; *V. parri* Cushman (1936:

2) (Gingin chalk), Upper Cretaceous of Australia; *V. superba* Earland (1934: 118), Recent in the Antarctic; *V. spiculotesta* Cushman (1935: 2), Recent off Puerto Rico; and "*V.*" *cummingensis* Nauss (Cummings member of the Mannville formation), Upper Cretaceous of Alberta, Canada. Nauss (1947: 340) stated, "Further study may reveal that these arenaceous Foraminifera with subcircular cross-section should be considered a new genus. . ." but tentatively referred the species to *Verneuilina*.

The species *Verneuilina schizea* Cushman and Alexander was selected as the genotype for a number of reasons. The writers have a large suite of topotypes of this species and have studied the holotype at the Cushman Laboratory. This species shows all the generic characters well, is quite abundant in the Lower Cretaceous Goodland formation where it occurs, and material from the type locality at the Lake Worth Dam near Fort Worth, Tex., is easily obtainable. Many of the other species referred above to *Verneuilinoides* are extremely rare or from dredgings or well material so that topotypes or representative material cannot easily be obtained by future workers.

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ENTOMOLOGY.—*The caddisfly genus* Neothremma *Banks* (*Trichoptera: Limnephilidae*).[1]

HERBERT H. ROSS, Illinois State Natural History Survey, Urbana, Ill.

Until recently the very interesting genus *Neothremma* has been known only on the basis of the genotype, *alicia* Banks. A few years ago Dr. W. E. Ricker sent me material of a second species, which is of great assistance in giving a little better perspective to the facies of the genus. The two species may be separated by the following key:

Male with lateral process of ninth segment nearly straight, its apical fork vertical in position and with nearly equal arms, Fig. 2; fused claspers elongate and only slightly emarginate at apex, Fig. 2*A*. Female with subgenital plate narrowing toward apex and very deeply and widely emarginate, Fig. 2*B*............*alicia* Banks

Male with lateral process of ninth segment strongly curved ventrad, the fork horizontal, the inner finger much shorter than the outer, Fig. 1; fused claspers short and tri-emarginate, with a pair of sharp points near the meson, Fig. 1*B*. Female with subgenital plate expanding toward apex, the apical margin obliquely emarginate, with a slightly deeper but small cleft in the middle, Fig. 1*C*............................*didactyla*, n. sp.

Neothremma didactyla, n. sp.

Male.—Length 6.5 mm. Color moderately dark brown, antennae and legs below coxae yellowish brown. General structure of warts, spurs, and venation typical for *alicia*. Maxillary palp subequal in length to labial palp, first and third segments short and subequal, second segment one and one-half times length of third, all three with a sparse mesal brush of fairly long, irregular hair. Front of head with mesal sclerite bearing a patch of sparse setae which have

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[1] Received January 7, 1949.

a long thread and a short, flattened, scalelike apex. Tibiae with only a few scattered spines in addition to the tibial spurs. Male genitalia exhibiting the general features of the peculiar type associated with this genus, Fig. 1. Ninth segment narrow dorsally but fairly long laterally, bearing near the middle of the posterio-lateral margin a long sclerotized process (which may represent the cercus), which is strongly curved ventrad and is forked at the tip, the forking being seen best from a posterio-dorsal view, Fig. 1*A*, showing the short inner finger; below this process is a large wide and flat process only half as long as the forked one, and covered with spiculations. The two claspers are fused, and the apical margin of this single structure, Fig. 1*B*, is divided into broad lateral lobes and a pair of closely approximated mesal projections which are pointed and curved dorsad. Tenth tergite forming a pair of closely appressed, heavily sclerotized blades which are very long and curve ventrad, extending beyond the other parts of the genitalia. Aedeagus and its accessory structures forming a short broad structure, the tip of the aedeagus projecting as a slender sclerotized rod.

Female.—Size, color, and general structure typical for male. Maxillary palp normal for family, longer than labial palp, the first two segments short, the next three longer. Front of head without areas of petiolate scales. Genitalia, Fig. 1*C*, having a large single subgenital plate, narrowest at base, its apical margin

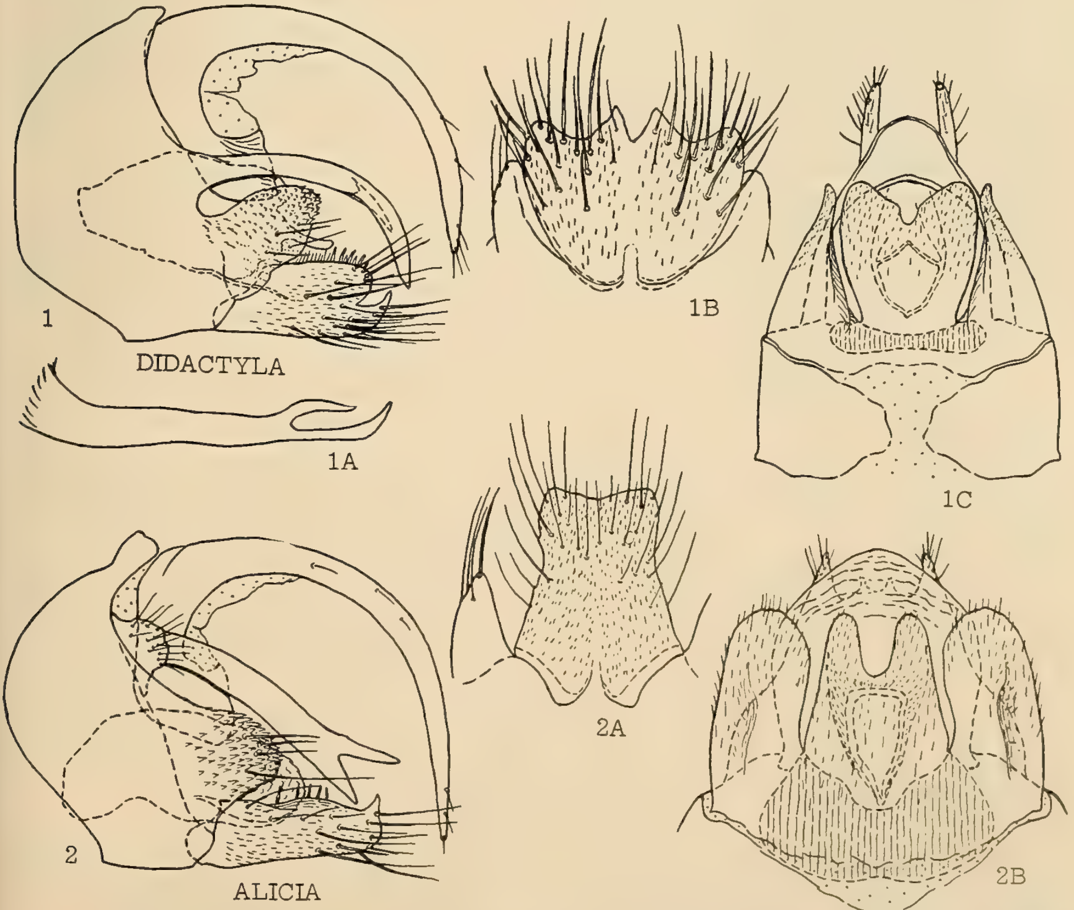

Fig. 1.—*Neothremma didactyla*, male genitalia, lateral view: 1*A*, Posterio-dorsal aspect of forked process; 1*B*, claspers, ventral aspect; 1*C*, female genitalia, ventral aspect.

Fig. 2.—*Neothremma alicia*, male genitalia, lateral aspect: 2*A*, Claspers, ventral aspect; 2*B*, female genitalia, ventral aspect.

incised as shown. Lateral lobes of ninth segment tapering to apex and pointed. Subgenital plate connected to an internal basal sclerotized plate which is small and bandlike.

Types.—Holotype, male: Mount Baker, Wash., along small creek, elevation 6,000 feet, August 29, 1946, W. E. Ricker. Allotype, female, and 9 male and 1 female paratypes: Same data as holotype. Deposited in the collection of the Illinois Natural History Survey.

ZOOLOGY.—*Some millipeds of the families Polydesmidae and Xystodesmidae.*[1]

Ralph V. Chamberlin, University of Utah. (Communicated by C. F. W. Muesebeck.)

The new forms of millipeds diagnosed and illustrated in the present paper are represented in the author's collection where all types are for the present retained.

Family Polydesmidae

Ergodesmus n. gen.

A genus close to *Nearctodesmus.* The gonopods are short and compact. As in *Nearctodesmus,* there are three divisions or branches in the telopodite of the male gonopods, but one of these is anterior and one posterior in position, instead of both arising from the anterior side of the principal division. Of the three branches the anterior one is segmented, with its distal subdivision slenderly acuminate and forming part of a circle. The posterior branch is closely applied to the main or median division against the apical part of which it curves.

Orthotype: *Ergodesmus compactus,* n. sp.

Ergodesmus compactus, n. sp.

Dorsum light reddish brown. Legs and antennae yellow.

The distinctive features of the gonopods of male, as described above under the genus, are shown in Fig. 1.

Width of male holotype, 2.5 mm.

Type locality.—Washington: Between Goldendale and Mayfield. About a dozen males and females taken May 20, 1941, by R. V. Chamberlin.

Other records.—Washington: Richland, two males taken September 17, 1935, by R. V. Chamberlin; Orondo, several specimens, mature and immature, taken August 11, 1929, by Edith S. and R. V. Chamberlin.

Genus **Kepolydesmus** Chamberlin

Kepolydesmus Chamberlin, Ann. Ent. Soc. Amer. **3** (4): 246. 1910.

Generotype: *Kepolydesmus anderisus* Chamberlin.

A genus distinguished from *Nearctodesmus* primarily in having the outer branch of the telopodite of the male gonopods divided into two segments, which are distinctly separated, as shown in the accompanying figure for *K. hesperus.* Four species are at present known for the genus.

Kepolydesmus anderisus Chamberlin

Fig. 2

Polydesmus (*Kepolydesmus*) *anderisus* Chamberlin, Ann. Ent. Soc. Amer. **3** (4): 246, pls. 36: 6–9, 37: 1–4. 1910.

Type locality.—Idaho: Latah County, Kendrick.

Other localities.—Idaho: Kootenai County, Canyon, and Roselake, Fourth of July Canyon, R. V. Chamberlin coll., 1929; Clearwater County, Kooskia, males and females taken August 23, 1940

Kepolydesmus hesperus, n. sp.

Fig. 3

Dorsum reddish brown with caudal corners of tergites yellow. Antennae brown, in part of pink tinge. Legs light pink.

Outer branch of gonopods notably broader than in *mimus* but proportionately somewhat narrower than in *anderisus,* the apex of its distal division more acutely pointed than in *mimus.* The ectal hook at distal end of middle division larger than in the other two species mentioned and the adjacent distal lobe more acutely prolonged. See further Fig. 3.

Length, 25 mm; width, 3.8 mm.

Locality.—Oregon: Ashland. Four males taken September 9, 1935, by R. V. Chamberlin.

Kapolydesmus mimus Chamberlin

Kepolydesmus mimus Chamberlin, Proc. Biol. Soc. Washington **70:** 10, pl. 10: 3. 1947.

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[1] Received January 3, 1949.

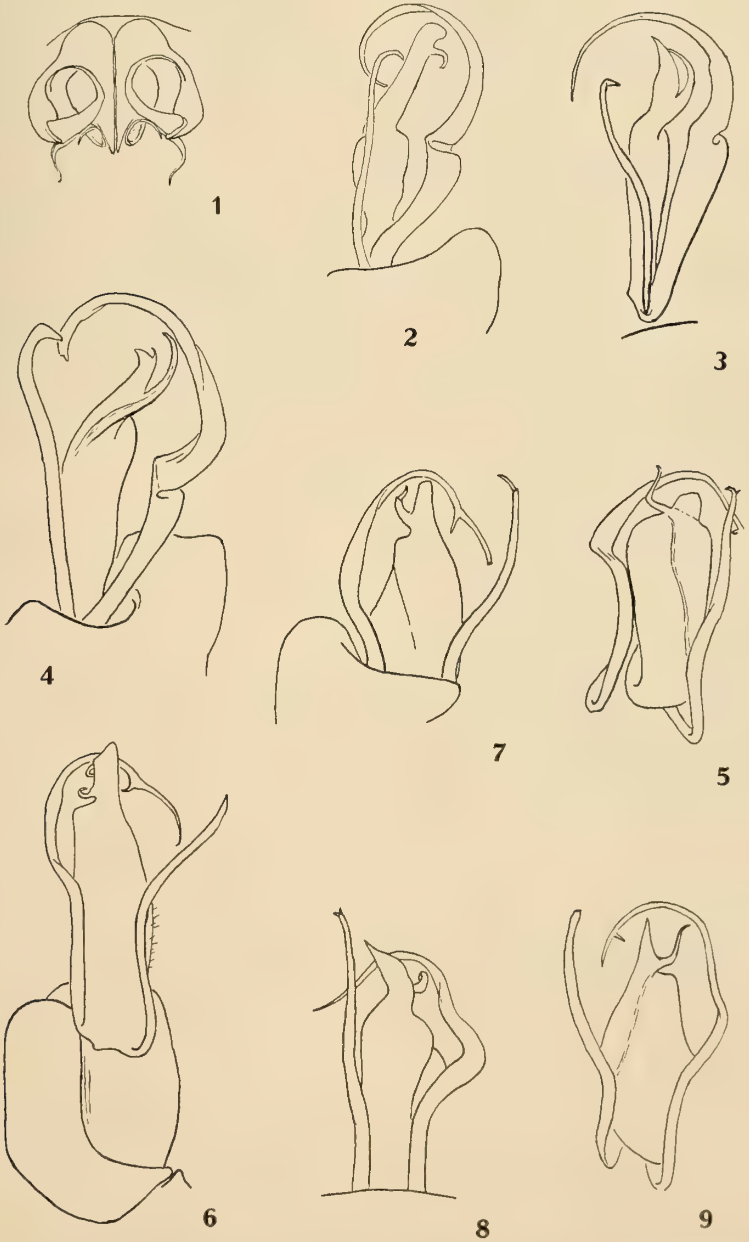
Type locality.—Washington: Skamania County Martha Creek at Carson.

Other localities.—Oregon: Canyon Creek, males and females taken September 9, 1935, by R. V. Chamberlin; near Roseburg, males and females, August 30, 1931.

Kepolydesmus pungo, n. sp.

Fig. 4

Dorsum and antennae dark reddish brown. The posterior corners of the tergites yellow as usual. Legs pink or yellow of a decided pinkish tinge.



FIGS. 1–9.—1, *Ergodesmus compactus*, n. sp., gonopods of male; 2, *Kepolydesmus anderisus* Chamberlin, right gonopod of male; 3, *Kepolydesmus hesperus*, n. sp., right gonopod; 4, *Kepolydesmus pungo*, n. sp., right gonopod; 5, *Nearctodesmus amissus*, n. sp., left gonopod; 6, *Nearctodesmus brunnior*, n. sp., left gonopod; 7, *Nearctodesmus campicolens*, n. sp., left gonopod; 8, *Nearctodesmus pseustes*, n. sp., right gonopod; 9, *Nearctodesmus renigens*, n. sp., right gonopod. All anterior aspects.

Of the known species probably closest to *K. mimus*. Distinguishable from that species most readily in the terminal lobe of the principal branch of the gonopods, this lobe being bifid instead of entire and acuminate. For this and other details see Fig. 4.

Width, 3.2 mm.

Type locality.—Oregon: Horsetail Falls. Two adult males, one adult female, and several immature specimens taken August 4, 1929, by R. V. Chamberlin.

Other record.—Oregon: Latourell Falls. Males and females taken by Edith S. and R. V. Chamberlin, August 4, 1929.

Genus **Nearctodesmus** Silvestri

Nearctodesmus Silvestri, Zool. Anz. **35**: 364. 1910.

Orthotype: *Nearctodesmus cerasinus* (Wood)

Seven species, as listed below, are at present known to conform to this genus. Of these six are named and described here as new.

Nearctodesmus amissus, n. sp.

Fig. 5

Dorsum brown, tinged with usual cherry red, which may have been more pronounced in the living specimens.

Set apart on the basis of differences in the gonopods of the male. These much suggest those of *N. pseustes*. The terminal lobe of the median body is shorter and not acutely pointed as it is in the latter; the mesal process presents no subapical tooth and the distal end of the outer process is bent at right angles, not finely drawn out. See further Fig. 5.

Width, 2.8 mm.

Type locality.—Oregon: exact locality not given. Many specimens were collected.

Other record.—British Columbia: Vancouver. Males and females taken "in mossy tree trunks" in September 1932 by Hugh Leech.

Nearctodesmus brunnior, n. sp.

Fig. 6

In contrast with *N. cerasinus*, with its cherry-red color, the present species has the dorsum definitely brown, with caudal corners yellow. The legs are proximally yellow, and darker, more brownish distally. Antennae brown.

In the gonopods the slender outer process, which curves about the free end of the main body, is like that of *N. cerasinus* in having a lateral barb toward distal end, but this is more remote from the apex. The principal body of the gonopod differs from that of *cerasinus* in the structure of the distal end, where it is narrowed and presents two characteristic short processes which curve caudad. See further Fig. 6.

Length, about 24 mm; width, 3 mm.

Locality.—California: 9 miles north of Crescent City. Six specimens taken in the redwoods on Highway 199 by Roth and Brown.

Nearctodesmus campicolens, n. sp.

Fig. 7

Coloration typical, the dorsum being reddish brown, sometimes darker and almost chocolate colored, and the legs reddish yellow or pink.

This species is closest to *N. brunnior* in structure of the gonopods in having the outer branch spurred some distance proximad of the tip, etc. It is distinct from that species in having but a single subapical hook on the median body instead of two. Other features are as shown in Fig. 7.

Length, 24 mm; width, 3 mm.

Locality.—California: Prairie Creek Park, Route 101, Red Wood Fort. July 10, 1940, male and females taken by S. and D. Mulaik.

Nearctodesmus cerasinus (Wood)

Polydesmus cerasinus Wood, Proc. Acad. Nat. Sci. Philadelphia 1864: 6

Type Locality.—Oregon. In view of the fact that several species of *Nearctodesmus* are now known, with probably others yet to be found, it seems impossible at present to be sure of Wood's original species. It is probably not the form figured by Silvestri as such (Zool. Anz. **35**: 364, fig. 10, 1910) but is very close to the species here described as *brunnior*.

Nearctodesmus pseustes, n. sp.

Fig. 8

Dorsum reddish brown, but the cherry-red pigment characteristic of most species of the genus is less pronounced in the type specimen than in most. Legs yellow.

Structurally the species suggests *Kepolydesmus mimus*. Though the gonopods of the male are superficially similar to those of that species, they differ in having the outer branch more sinuous and especially in lacking the submedian break or joint in this branch prominent in *mimus*. The mesal branch is longer and presents a small subterminal tooth. The principal body is also distally different as shown in fig. 8.

Width of male holotype, 2.5 mm.

Locality.—Oregon: Boyer. Male holotype taken June 13, 1936, by J. A. Macnalb.

Other records.—Oregon: Comstock, seven specimens taken September 16, 1935, by R. V. Chamberlin. Washington: Precise locality not given. One male and an immature specimen.

Nearctodesmus renigens, n. sp.

Fig. 9

Dorsum and antennae brown, the legs yellow. Similar to *N. brunnior* in having a lateral spur toward distal end of the outer process of gonopods, but readily distinguished from that species in having only one subapical hook on the median body instead of two and in other details as shown in Fig. 9.

Width, 3 mm.

Locality.—Oregon: Probably near Corvallis, male holotype and 2 females.

Nearctodesmus salix, n. sp.

Fig. 10

The metatergites above and laterally rose-colored. Antennae brown. Legs yellow, in some cases partly tinged with pink or rose.

The male is distinct from other known species in the comparatively heavy and furcate terminal portion. The inner ramus without subapical tooth, middle body with main branch extruding farther distad beyond it than is usual. See further Fig. 10.

Width, 3.2 mm.

Type locality.—California: 12 miles west of Willow Creek. One male and two females taken July 9, 1946, by S. and D. Mulaik.

Genus **Pseudopolydesmus** Attems

Pseudopolydesmus Attems, Denkschr. Akad. Wis. Wien **67:** 270, 479. 1898.

Orthotype: *Pseudopolydesmus serratus* (Say).

Pseudopolydesmus caddo, n. sp.

Fig. 11

A small form in which the dorsal tubercules are only moderately developed and in which the lateral margins of the keels show three notches behind the tooth at anterior corner.

Gonopods of the male characterized by having the ectal margin of the blade above middle expanded into a characteristic lamina, as shown in Fig. 11.

Length, 11–12 mm; width, 1.7 mm.

Type locality.—Louisiana: Caddo Parish, 5 miles northwest of Shreveport. Two males and one female taken April 13, 1936, by Leslie Hubricht.

This species is closely related to *P. neoterus* Chamberlin, known from New Orleans, in its size and general structure but differing in the details of the gonopods, e.g., in the lateral lamina and distal portion of the telopodite.

Family Xystodesmidae

Amplocheir, n. gen.

In general structure of body agreeing with *Xystocheir*. The gonopods differ from those of *Xystocheir* in having the telopodite divided by a joint above its middle, the distal segment having two aciculiform spines while proximad of the joint there are three slender spines.

Orthotype: *Amplocheir sequoia* (Chamberlin).

Amplocheir sequoia (Chamberlin)

Figs. 12, 13

Xystocheir sequoia Chamberlin, Bull. Univ. Utah, biol. ser., **6** (5): 15; *3: 28. 1941.

Type locality.—California: Tulare County, Sequoia National Park, 10 miles east of Hammond.

Cheirauxus, n. gen.

A genus separated from *Xystocheir* primarily on the basis of the presence of a fifth spine on the telopodite of the gonopods. This arises on the mesal side from the base of the two larger distal mesal spines.

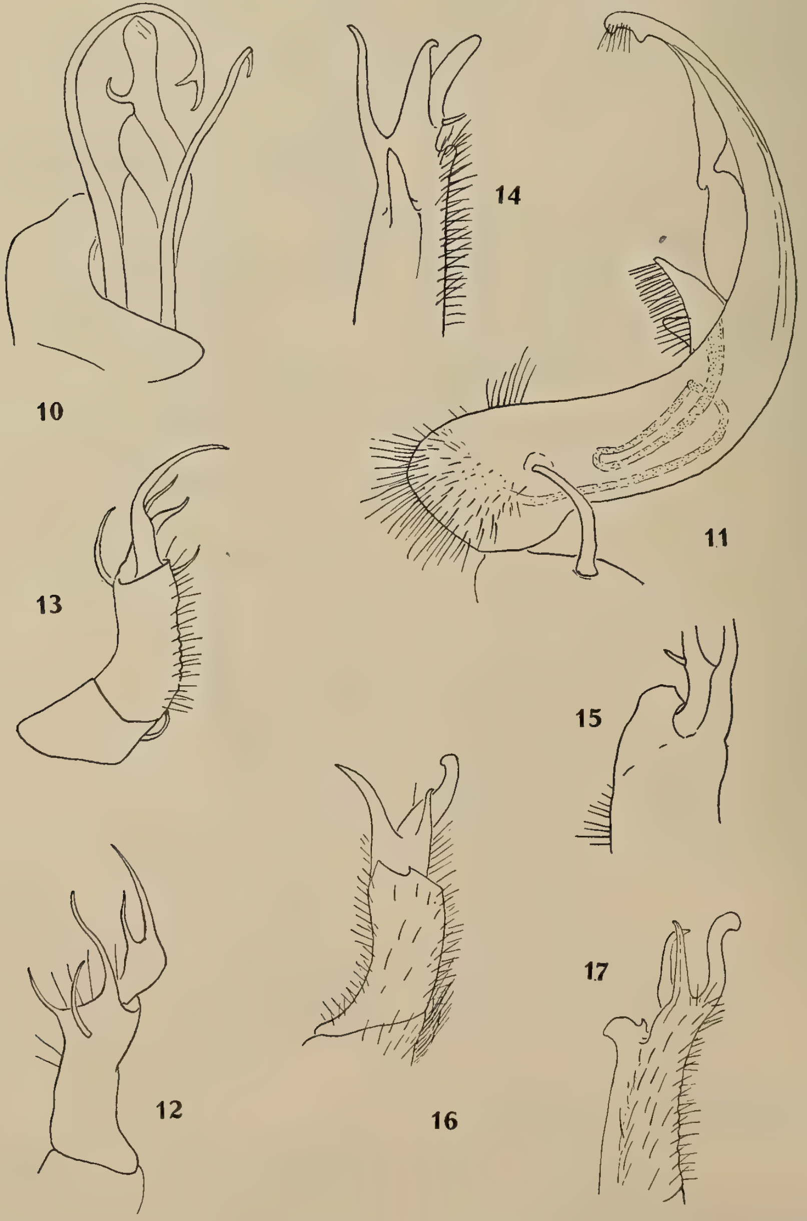
Orthotype: *Cheirauxus sapiens*, new species.

Cheirauxus sapiens, n. sp.

Figs. 14, 15

The male of this species seems to be readily distinguishable in the gonopods from any previously known in bearing a short straight spine on mesal side, just proximad of the point of separation of the two terminal rami, as well as in the details of the other branches as shown in the figures (Figs. 14, 15). Though *Amplocheir sequoia* has a similar supplementary spine, this in the latter species is much longer and the form and relations of the principal rami are obviously different.

In size and proportions like *X. acuta* Cook with the lateral carinae similarly strongly and acutely produced. It might prove to be the same as Cook's species, but it seems hardly possible that this observer would have overlooked the characteristic supplementary spine mentioned above.



Figs. 10–17.—10, *Nearctodesmus salix*, n. sp., left gonopod, anterior aspect; 11, *Pseudopolydesmus caddo*, n. sp., right gonopod, mesal aspect; 12, *Amplocheir sequoia* (Chamberlin), right gonopod, anterior aspect; 13, *Amplocheir sequoia* (Chamberlin), right gonopod, subectal view; 14, *Cheirauxus sapiens*, n. sp., left gonopod, distal portion of telopodite, anterior view; 15, *Cheirauxus sapiens*, n. sp., right gonopod, distal portion of telopodite, ventroectal view; 16, *Delocheir taibona* (Chamberlin), left gonopod, subanterior aspect; 17, *Delocheir taibona* (Chamberlin), left gonopod, distal portion of telopodite, submesal aspect.

Length, 34 mm; width, 6.4 mm.

Type locality.—California. Palo Alto. Male holotype taken in 1928 by R. V. Chamberlin.

Delocheir, n. gen.

Differing in the male gonopods from *Xystocheir* in having the anterior finger or ramus replaced by a lamina or thin transverse plate.

Orthotype: *Delocheir taibona* (Chamberlin)

In addition to the generotype the two new species diagnosed below belong in this genus.

Delocheir taibona (Chamberlin)

Figs. 16, 17

Xystocheir taibona Chamberlin, Ann. Ent. Soc. Amer. **5:** 170; *10: 1, 2. 1912.

Type locality.—California: Region of Monterey Bay (Pacific Grove, etc.).

Delocheir conservata, n. sp.

Fig. 18

Related to *D. taibona* but apparently lighter colored, the dorsum pale fawn-colored with keel yellow. Legs light yellow. Keels normal; the processes of those of eighteenth tergite with apices in line with those of the nineteenth.

From *taibona* conspicuously different in the gonopods. In these the posterior terminal spine is long and sigmoidally curved, much exceeding the adjacent median spine, relatively much longer than in *taibona* and differently shaped. The anterior lamina broad, its margin evenly rounded and entire, lacking the conspicuous notch present in the other two species. See further Fig. 18.

Length, about 28 mm; width, 6 mm.

Type locality.—California: Monterey County, Hastings Reservation. A male and female taken separately on April 9, 1938, and March 25, 1938.

Delocheir dalea, n. sp.

Fig. 19

Close in general structure to *D. taibona*, with which it agrees in having the lower or anterior (ventral) finger or ramus of *Xystocheir* replaced by a thin transverse membrane or lamina. It is readily distinguishable from that species in the form of the posterior terminal spine of the gonopods this being relatively much shorter and ending in a characteristic lamina. The transverse membrane lacks the notch present in that of *taibona* and *conservata* toward its outer end. For these and other differences in detail see Fig. 19 in comparison with Figs. 16 and 17.

Dorsum and legs brown. Keels of tergites of posterior part of body produced in degree usual in *Xystocheir;* processes of eighteenth segment nearly attaining level of apices of those of the nineteenth.

Length, about 37 mm; width, 6.5 mm.

Type locality.—California: Brookdale. Males and females taken March 13, 1913, by R. V. Chamberlin.

Genus **Xystocheir** Cook

Xystocheir Cook, Harriman Alaska Exped. **8** (1): 53. 1904.

Orthotype: *Xystocheir acuta* Cook.

Xystocheir francisca, n. sp.

Fig. 20

This is the smallest of the known species of *Xystocheir*. The color above is light testaceous-brown in the preserved specimen. The lateral keels are only moderately produced, with the apices of processes narrowly rounded.

The gonopods of the male seem distinctive. In these the posterior terminal spine is lamellate and curves conspicuously mesad across the erect anterior one; the anterior ramus is proportionately short, bends strongly ectad above base and is expanded at distal end. See further Fig. 20.

Width, 5 mm.

Type locality.—California: San Francisco. Male holotype taken by C. C. Cross.

Xystocheir milpitas, n. sp.

Figs. 21, 22

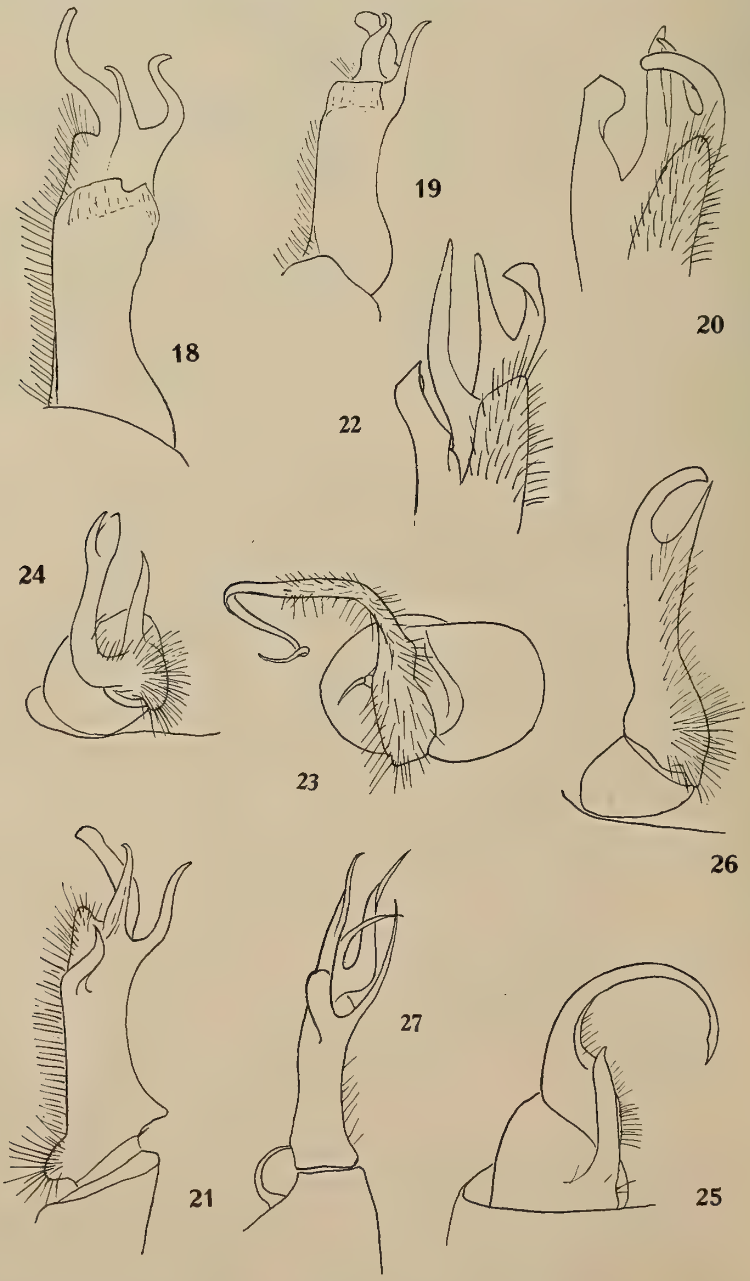
Dorsum of the usual light testaceous-brown with keels paler. Legs yellow. Lateral keels but little produced except on most posterior segments; processes of nineteenth segment much reduced, those of nineteenth large and extruding caudal about to level of the apices of the former.

The two apical spines of the male gonopod but little divergent, the posterior (ventral) of these curving conspicuously mesad and a little expanded at the distal end. The anterior ramus curving ectad, distally subtruncate, with distal corner of end produced. See further Figs. 21 and 22.

Length, 28-30 mm; width, 6.2-6.5 mm.

Type locality.—California: Scrub pine hills east of Milpitas. Four specimens taken February 1, 1928, by J. C. Chamberlin.

Differs from *X. dissecta* (Wood) in details of gonopods, e.g., in the anterior ramus, which is distally truncate with upper corner acutely produced instead of being distally rounded, etc.



Figs. 18–27.—18, *Delocheir conservata*, n. sp., left gonopod, anterior aspect; 19, *Delochir dalea*, n. sp., left gonopod, anterior aspect; 20, *Xystocheir francisca*, n. sp., left gonopod, apical part of telopodite, mesal view; 21, *Xystocheir milpitas*, n. sp., right gonopod, anterior view; 22, *Xystocheir milpitas*, n. sp., left gonopods, distal part of telopodite, mesal view; 23, *Apheloria tortua*, n. sp., left gonopod, ventral view; 24, *Epeloria nannoides*, n. sp., right gonopod, ventral view; 25, *Phanoria philia*, n. sp., right gonopod, anterior view; 26, *Zinaria mima*, n. sp., gonopod, anterior view; 27, *Xystocheir tularea*, n. sp., right gonopod, anterior view.

Xystocheir tularea, n. sp.

Fig. 27

The types of this form are too much bleached out from long preservation to reveal the original coloration with certainty, but it appears to have been testaceous,

This species is obviously distinct from *dissecta* and other known species in the form of the gonopods, particularly in the character of the anterior spine. This is relatively unusually long and is distally slenderly acuminate while proximally laminate. Of the other spines, the two outer ones are erect and long, while the mesal one is shorter and curves strongly ectad. See further fig. 27.

Width, 6.8 mm.

Type locality.—California: Tulare County, Sugar Loaf Mountain at altitude 6,000 feet. Male and female taken in April 1930 by K. Dennen.

Genus **Apheloria** Chamberlin

Apheloria Chamberlin, Can. Ent. **53**: 232. 1921.

Apheloria asburna, n. sp.

Dorsum dark brown, in part chocolate-colored; a rather narrow but sharply defined band across caudal border of tergites, this expanding laterad and embracing entire keels; apical portion of cauda yellow; legs yellow and antennae brown.

Coxae of legs of posterior region conspicuously spined; spines of second joint large. Sternite not spined.

In form of telopodite of gonopods resembling *A. tigana* Chamberlin of North Carolina; but the blade narrower and the basal spine only moderately curved instead of being strongly uncate.

Width, 10 mm.

Locality.—Tennessee: 20 miles north of Nashville. One male taken July 17, 1933.

Apheloria tortua, n. sp.

Fig. 23

Tergites dark brown to black with a large yellow median area occupying the posterior two-thirds of length; keels yellow excepting the anteromesal corner. Cauda and legs yellow, antennae brown.

None of the coxae and sternites spined.

The male gonopods seem distinct in the form of the distal portion of the telopodite and of the basal spine as shown in Fig. 23.

Length, about 39 mm; width, 9 mm.

Type locality.—Virginia: Mountain Lake. One male taken by A. C. Cole in July 1942.

Genus **Epeloria** Chamberlin

Epeloria Chamberlin, Bull. Univ. Utah, biol. ser., **5** (3): 3. 1939.

Orthotype: *Epeloria talspoosa* Chamberlin.

Epeloria nannoides, n. sp.

Fig. 24

The type specimen, which is apparently not in full color, has the tergites light orange, with keels and a band across caudal border of each tergite yellow. Legs yellow.

The gonopods of the male are quite distinct from those of any previously described. See Fig. 24.

Width, 4 mm.

Type locality.—Florida: Gainesville. One male taken February 10, 1942.

Phanoria, n. gen.

Telopodite of male gonopod a simple apically acute blade curved in a semicircle; on anterior side of coxa a process in form of an erect blade, in this differing, for example, from *Sigmoria.*

Orthotype: *Phanoria philia,* n. sp.

Phanoria philia, n. sp.

Fig. 25

Dorsum dark brown, with a rather broad yellow band across caudal border of each tergite and its keels, the lateral borders of the latter and the cauda also yellow.

Posterior coxae bearing apically conical points or spines, but the sternites not spined.

Telopodite of male gonopod apically of hastate form. Anterior process from coxa a straight, apically acute blade. See further Fig. 25.

Width of male holotype, 9 mm.

Type locality.—Georgia: Clarkesville. One male taken April 27, 1943.

Genus **Zinaria** Chamberlin

Zinaria Chamberlin, Bull. Univ. Utah, biol. ser. **5** (3): 4. 1939.

Orthotype: *Zinaria cala* Chamberlin.

Zinaria mima, n. sp.

Fig. 26

Dorsum brown, in part chestnut; a narrow yellow band along caudal margin of each tergite, this band somewhat expanded at middle, embracing caudal corner of keels and continued forward on lateral margin of keel in a narrow line, less broadly embracing keel than usual in *butleri*. Cauda yellow. Legs yellow.

In the gonopods the male differing from *butleri* in having the prongs of the telopodite more erect and distally less divergent as shown in Fig. 26.

Length of female allotype about 25 mm; width, 6 mm. Male holotype a little smaller.

Type locality.—Pennsylvania: Greene County. Two males and three females taken July 29, 1926, by T. L. Guyter.

Perhaps the northern representative of *Z. cala*, which it suggests in the position of the terminal prongs of the gonopods of male, but in *cala* these are more nearly parallel and thus much more widely divergent distally.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

424TH MEETING OF BOARD OF MANAGERS

The 424th meeting of the Board of Managers, held in the Cosmos Club, January 10, 1949, was called to order at 8:05 P.M. by the President, Dr. FREDERICK D. ROSSINI. Others present were: H. S. RAPPLEYE, N. R. SMITH, W. L. SCHMITT, W. W. DIEHL, F. M. DEFANDORF, W. RAMBERG, C. F. W. MUESEBECK, W. W. RUBEY, W. A. DAYTON, C. A. BETTS, M. A. MASON, L. A. ROGERS, O. B. FRENCH, C. L. GAZIN, and, by invitation, H. E. MCCOMB, R. J. SEEGER, ALAN STONE, F. C. KRACEK, L. V. JUDSON, F. H. H. ROBERTS, JR., and FRANK THONE.

The President announced that Ernest G. Holt, of the Soil Conservation Service, Department of Agriculture, had been delegated to represent the Academy at the Seventh Pacific Science Congress to be held in New Zealand during February 1949.

The Executive Committee met informally by telephone on January 10 and concurred in recommending to the Board of Managers that an additional $156 be allotted to the Secretary's office to cover expenses incurred in 1948 beyond the original $400 budget allotment.

The Board of Managers approved the additional sum for the 1948 expenses of the Secretary's office.

The chairman of the Committee on Meetings, Dr. R. J. SEEGER, discussed the problem of getting the membership out for the meetings. It was generally concluded that more emphasis should be put on joint meetings and that efforts should be made to get occasional meetings of more interest to engineering groups.

The chairman of the Committee on Membership, H. E. MCCOMB, presented three nominations for resident membership.

The chairman of the Committee on Monographs, Dr. L. V. JUDSON, announced that the monograph on *The Parasitic cuckoos of Africa* was in the process of being bound. The sum of $2,300 was cited as the final cost of printing the monograph, indicating a cost of $4.70 per copy necessary to secure a return of the investment on sale of one-half the issue. The committee recommended a figure of $4.50 as the price to be charged and the Board of Managers concurred.

C. F. W. MUESEBECK, acting for the chairman of the general Committee on Awards for Scientific Achievement in 1948, presented the following three recommendations for the Awards:

> *Biological Sciences:* Dr. ROBERT J. HUEBNER, of the National Institutes of Health, in recognition of contributions to our knowledge of the transmission of certain rickettsial diseases.
>
> *Engineering Sciences:* Dr. MAXWELL K. GOLDSTEIN, of the Office of Naval Research, in recognition of distinguished research and development in the field of electronic engineering.
>
> *Physical Sciences:* Dr. J. A. VAN ALLEN, of the Applied Physics Laboratory of Johns Hopkins University, in recognition of his work in nuclear physics and cosmic rays.

The Board of Managers accepted the recommendation of the Committee on Awards for Scientific Achievement.

The chairman of the Committee on Grants-in-aid for Research, Dr. F. H. H. ROBERTS, JR., announced that the fund for grants-in-aid available from the A.A.A.S. would this year amount to about $325 and that applications for a grant from this fund are now receivable.

Capt. C. L. GARNER, having been retired from the gainful practice of his profession, was transferred to the retired list of members, effective December 31, 1948.

The Secretary announced the death of WILLIAM H. EMMONS, of the University of Minnesota, on November 5, 1948.

The Secretary also announced that with the concurrence of the Executive Committee and the chairman of the Meetings Committee, the Academy held a joint meeting with the Geological Society of Washington on January 3. Prof. HANS CLOOS, of the University of Bonn, spoke on *Geologic structures through the ages*.

The results of the ballot submitted to the membership in December proposing a new Article I for the By-laws (see minutes of the 420th meeting of the Board) were presented as follows:

In favor of the amendment	249
Opposed	3
Blank ballots	3
Ballots received	255

The Secretary informed the Board that he had received from Dr. W. N. FENTON, chairman of the Committee on the Index to the Journal, the contract for the work of indexing the Journal signed by Miss Mary Bradley and Dr. W. N. Fenton.

The Treasurer, H. S. RAPPLEYE, presented the names of two members who requested resignation because of retirement from their profession: CLYDE W. WARBURTON and ELMER D. MERRILL. A third member, WALTER F. STUTZ, requested transfer to life membership. Mr. RAPPLEYE called attention to the fact that these men had paid dues for 10 years and were eligible for retirement. The Board of Managers voted to place these names on the retired list of members, effective December 31, 1948.

The meeting was adjourned at 9:20 P. M.

C. LEWIS GAZIN, *Secretary.*

NEW MEMBERS OF THE ACADEMY

There follows a list of persons elected to membership in the Academy, by vote of its Board of Managers, since January 1, 1948, who have since qualified as members in accordance with the By-Laws. (See also previous list in May 15, 1948, issue of JOURNAL.) The bases for election are stated with the names of the new members.

RESIDENT

Elected January 12, 1948

NEIL W. STUART, botanist, Bureau of Plant Industry, Soils, and Agricultural Engineering, in recognition of his services and research in the field of nutrition, and effects of environmental factors on plant growth.

Elected April 12, 1948

DANIEL C. LEWIS, JR., mathematician, University of Maryland, in recognition of his contributions to the mathematical theory of dynamical systems and his work upon the four-color problem.

DICK WICK HALL, mathematician, University of Maryland, in recognition of his contributions to the field of topology.

L. MARTON, physicist, National Bureau of Standards, in recognition of his contributions to modern experimental physics, especially his pioneering role in the development of electron microscopy.

EDOUARD H. SIEGLER, entomologist, Bureau of Entomology and Plant Quarantine, in recognition of research in insecticides, particularly with reference to fruit insects.

LYMAN B. SMITH, botanist, U. S. National Museum, in recognition of his contributions to taxonomic botany, especially of the Bromeliaceae and Begoniaceae of Central and South America, and his outstanding work at the Gray Herbarium.

B. D. VAN EVERA, chemist, George Washington University, in recognition of his contribution to the war effort in World War II, his ability as an organizer of scientific projects, and his training of young men for professional careers in science.

Elected May 17, 1948

EDWARD W. BAKER, entomologist, Bureau of Entomology and Plant Quarantine, in recognition of his contributions to the classification of the Acarina (mites).

DONALD B. BROOKS, automotive engineer, National Bureau of Standards, in recognition of his important contributions in the field of automotive engineering, and in particlar for improvements in the precision of rating automotive engine fuels.

CLEDO BRUNETTI, electrical engineer, National Bureau of Standards, in recognition of his outstanding work in engineering electronics.

DEAN S. CARDER, geophysicist, U. S. Coast and Geodetic Survey, in recognition of his contributions to seismology, in particular "his research work on major crustal structure of the earth, the Pacific in particular, and the relation of reservoir loading to local earthquake activity," and his observational work on vibrations of structures and other work on engineering seismology.

Thomas J. Carroll, physicist, National Bureau of Standards, in recognition of his work on Faraday effect of diatomic molecules; radiowave propagation at microwave frequencies as applied to radar and relay communications.

Robert E. Gebhardt, geophysicist, U. S. Coast and Geodetic Survey, in recognition of his contributions in instrumental geomagnetism and seismology with special reference to the development of the Induction Field Magnetometer and visible recording seismographs.

Robert D. Huntoon, physicist, National Bureau of Standards, in recognition of his basic contributions to science of electronic ordnance, proximity fuze, stabilized missiles, etc.

J. W. Joyce, geophysicist, Department of the Navy, in recognition of his work in geomagnetism, geophysical prospecting, and airborne electronic equipment.

Raymond Morgan, physicist, University of Maryland, in recognition of his contributions to physics with particular reference to his work on X-ray and electron diffraction.

Walter J. Murphy, chemist, American Chemical Society, in recognition of his contributions to engineering chemistry.

Harold W. Murray, engineer, U. S. Coast and Geodetic Survey, in recognition of his special skills in the interpretation of hydrographic surveys and mapping of the ocean bottom.

Paul H. Oehser, science historian and editor, Smithsonian Institution, in recognition of his services to the sciences of natural history and to the history of science in Washington.

R. I. Sailer, entomologist, Bureau of Entomology and Plant Quarantine, in recognition of his contributions to the classification of the Hemiptera-Heteroptera.

Lansing G. Simmons, mathematician, U. S. Coast and Geodetic Survey, in recognition of his contributions to geodesy through his development of methods for computations of geographic positions, ultra precise geodetic surveys, and control surveys.

Charles B. Willingham, chemist, National Bureau of Standards, in recognition of his contributions to physical chemistry particularly as applied to fractionation of hydrocarbons in petroleum.

Elected June 7, 1948

Evelyn Anderson, endocrinologist, National Institutes of Health, in recognition of her contributions to the study of the endocrine glands.

Joseph M. Caldwell, electrical engineer, Beach Erosion Board, in recognition of his contributions to the science of hydraulics, particularly in the development of hydraulic model studies.

Dorland J. Davis, surgeon, U. S. Public Health Service, in recognition of his contributions to research on psittacosis.

Kenneth M. Endicott, surgeon, National Institutes of Health, in recognition of his contributions to pathology and toxicology of chemotherapeutic compounds.

Karl Habel, surgeon, National Institutes of Health, in recognition of his researches on rabies and mumps.

John A. Hipple, physicist, National Bureau of Standards, in recognition of his contributions to research in the field of mass spectrometry and electronics including important developments in instrument design and in molecular physics.

George A. Hottle, biochemist, National Institutes of Health, in recognition of his contribution to the application of chemical principles to biological problems.

Robert J. Huebner, assistant surgeon, National Institutes of Health, in recognition of his contribution to the investigation and identification of a new disease (rickettsialpox) with identification of the animal reservoir and the transmitting mite, and for his studies of Q fever and the demonstration of the presence of Q fever rickettsia in milk from cattle in the Los Angeles area.

James M. Hundley, medical research, National Institutes of Health, in recognition of his contributions to nutrition research, especially the relationships of vitamins and amino acids.

Ernest L. Jackson, chemist, National Institutes of Health, in recognition of his contributions to organic chemistry and chemotherapy.

Kenneth L. Knight, entomologist, Naval Medical Center, in recognition of his studies on the mosquitoes of the Pacific and Oriental regions, particularly of the genus *Aedes* and *Anopheles*.

R. D. Lillie, pathologist, National Institutes of Health, in recognition of his studies on gross and histological pathology of infectious diseases, and toxicological pathology of organic compounds.

Gordon W. McBride, chemist, U. S. Department of Agriculture, in recognition of researches in continuous process for soap, and other researches in chemical engineering.

Paul A. Neal, biologist, National Institutes of Health, in recognition of his work in industrial hygiene and toxicology.

Byron J. Olson, surgeon, National Institutes of Health, in recognition of his fundamental researches on tuberculosis and histoplasmosis.

John H. Park, physicist, National Bureau of Standards, in recognition of his work on electrical surges in particular in the field of measurement of transient surge currents of large magnitude.

Samuel B. Salvin, botanist, National Institutes of Health, in recognition of his researches in mycology.

Arnold H. Scott, physicist, National Bureau of Standards, in recognition of his work on the density and electrical properties of rubber.

Heinz Specht, physiologist, National Institutes of Health, in recognition of his research in physiology of respiration.

Robert M. Stephan, dental surgeon, National Institutes of Health, in recognition of dental research and research on biochemical mechanism by which tooth substance is destroyed in dental caries.

Herbert Tabor, surgeon, National Institutes of Health, in recognition of his studies on shock and vitamins.

Fletcher P. Veitch, Jr., biochemist, University of Maryland, in recognition of his contributions in biochemistry, and in particular his work on estrone.

W. F. Von Oettingen, toxicologist, National Institutes of Health, in recognition of his research in toxicology.

G. Forrest Woods, chemist, University of Maryland, in recognition of his researches in organic chemistry, and in particular his work on the chemistry of hexatriene.

Elected October 18, 1948

Norman F. Braaten, mathematician, U. S. Coast and Geodetic Survey, in recognition of his work in the processing and interpretation of geodetic-survey records and in particular for his development of the circuit-reduction method of the adjustment of leveling networks.

Victor H. Cahalane, biologist, National Park Service, in recognition of his contributions to mammalogy and to wildlife conservation and management.

NONRESIDENT

Elected May 17, 1948

Charles A. Thomas, chemist, Monsanto Chemical Co., St. Louis, Mo., in recognition of his work in development of tetraethyl lead, synthetic rubber, rocket propellants, chemistry of plutonium, etc.

Elected October 18, 1948

Alexander Silverman, chemist, University of Pittsburgh, Pittsburgh, Pa., in recognition of outstanding service as a teacher of chemistry and his contributions to the chemistry and technology of glass.

HONORARY

Elected May 17, 1948

Albert K. Fisher, zoologist (deceased since election), formerly of U. S. Department of Agriculture, in recognition of his distinguished service in ornithology and mammalogy.

GEOLOGICAL SOCIETY[1]

646th MEETING

The 646th meeting of the Society was held at the Cosmos Club, January 18, 1947, President W. P. Woodring presiding. A memorial to Dr. Gerald F. Loughlin was read by L. W. Currier.

New business.—The amendment to Article III, "Dues," of the Standing Rules was approved by the members.

Program.—Hugh D. Miser: *Petroleum geology in the United States Geological Survey.*

G. Edward Lewis: *El Sangay, and some other volcanoes of Ecuador.** An expedition to the least known of the world's great active volcanoes has resulted in the preparation of the first sketch map showing possible routes of approach to El Sangay. New data on El Sangay's activity were secured, together with a photographic record of this and other volcanoes of Ecuador.

William F. Guyton: *Industrial use of ground water in the United States.** Data compiled by the U. S. Geological Survey and by several State agencies[2] justify an estimate that the withdrawals of ground water in the United States in 1945 were about as follows:

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[1] Those abstracts marked with an asterisk* have been approved for publication by the Director of the U. S. Geological Survey.

Class of use	*1945 (Million gal./day)*
Irrigation	10,000
Industrial, not including water supplied from municipal systems	5,000
Municipal	3,000
Rural, not including irrigation	2,000
Total	20,000

The use of ground water has been increasing at a rapid rate. This has been due partly to increased production and unusual demands caused by the war, and partly to improved methods of locating, developing, and maintaining ground-water supplies.

The most rapid increase, by percentage, has been for industrial purposes. Ground water is preferred to surface water by many types of industries, especially where the demands are small to moderate. The principal reasons for this preference are ground water's availability, its freedom from bacterial and suspended matter, and its uniform temperature, which is generally lower than that of surface water during summer months.

Large quantities of ground water are pumped from small areas in many parts of the United States. Following is a table showing the total quantities of water withdrawn in 1945 in the 10 areas of largest concentrated withdrawal, together with the amounts withdrawn from private wells exclusively for industrial use.

Area	Total withdrawal	Industrial withdrawal
	(Million gallons a day)	
1. South Coastal Basin, Calif.	400 ±	40 +
2. Long Island, N. Y.	280	90 ±
3. Houston-Baytown-Galveston Co.-Katy, Tex.	218	115 ±
4. Memphis, Tenn.	105	74
5. San Antonio, Tex.	100	15
6. East St. Louis, Ill.	89	85
7. Peoria-Pekin, Ill.	86	67
8. Chicago, Ill.	84	48
9. Dayton, Ohio	73	40
10. Cincinnati-Mill Creek Area, Ohio	69	67

In 19 areas[3] where pumpage inventories have been made (mostly in 1945), the total amounts of ground water withdrawn by various types of industry were as follows:

Type of industry	Withdrawal (Million gal./day)	Number of cities represented
1. Oil refining	71	8
2. Metal working	57	10
3. Paper manufacturing	51	4
4. Chemical manufacturing	50	5
5. Distilling	47	3
6. Rubber manufacturing	40	3
7. Buildings, air conditioning, refrigerating	40	13
8. Food processing	35	9
9. Ice making and cold storage	32	11
10. Meat packing	32	9
11. Brewing	20	6
12. Railroads	17	10
13. Dairying	13	7

Other important uses include requirements of gas and electrical plants, aircraft plants, ordnance plants, resinous products manufacturing, and mines.

Because of the rapid expansion in development of ground water, numerous problems have arisen which occasionally have caused people to think there is a general shortage of ground water in the United States. This is far from the truth. On the contrary, the ground-water future of the United States is very bright indeed. The trouble spots will gradually be eliminated by proper distribution of wells, legal control, and the like; and there are tremendous untouched reserves and possibilities for increasing existing supplies. Modern knowledge and methods will assure successful and economical development of these supplies. For—what most people do not realize—the actual results of scientific ground-water investigations today make the most exaggerated claims of water witches sound like child's play!

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[2] The Illinois State Water Survey furnished nearly all the data for Illinois.

[3] Chosen at random, and not necessarily areas of largest withdrawal. Louisville, Ky.; Houston-Baytown-Texas City, Tex.; Philadelphia, Pa.; Pittsburgh, Pa., 80 per cent; El Dorado, Ark.; Benton Harbor, Mich.; Akron, Ohio; Kansas City, Kan.; Chillicothe, Ohio; South Bend, Ind.; Miami, Fla.; Jacksonville, Fla.; Pensacola, Fla.; Okla. City, Okla.; Peoria-Pekin, Ill.; East St. Louis, Ill.; Chicago, Ill.; Minneapolis-St. Paul, Minn.; Milwaukee, Wis., 65 per cent.

647TH MEETING

The 647th meeting of the Society was held at the Cosmos Club, January 22, 1947, Vice-President Ernst Cloos presiding.

Informal communication.—Robert Chapman presented some observations on Aufeis in Alaska.

Program.—R. S. Allan: *Origin, distribution, and ecology of Tertiary brachiopods of the Southern Hemisphere.*

Marcus I. Goldman: *Bauxitization—a tropical disease.** In a recent paper in Economic Geology, Goldman and Tracey pointed out that there is, in the bauxitized nepheline syenite of Arkansas, abundant evidence of kaolinization of bauxite but no evidence known to them of bauxitization of kaolin, and that the kaolin occurring between fresh and bauxitized nepheline syenite is dense and structureless whereas the bauxitized nepheline syenite retains the texture of the fresh nepheline syenite. They therefore suggested that the bauxite has been formed directly from the nepheline syenite, not from kaolinized nepheline syenite. Among the evidences of kaolinization are patches of kaolin, in bauxitized nepheline syenite, enclosing pseudofragmental remnants of the bauxite. The occurrence of such patches adjacent to unbauxitized cores of nepheline syenite in process of kaolinization is regarded as evidence that silica escaping from the kaolinizing cores resilicated (kaolinized) the adjacent bauxite. This, the speaker suggested, is almost conclusive evidence that kaolin was not an intermediate stage in the bauxitization of the nepheline syenite as rekaolinization of any bauxite assumed to have formed around a kaolinizing core would prevent the formation of bodies of bauxite, such as now exist in Arkansas, outside such cores.

Citing previously expressed opinions that the difference between conditions favoring kaolinization and those favoring bauxitization could not be attributed to mere difference in climatic factors but probably involved the participation of microorganisms, the speaker made the point that it is particularly difficult to conceive of two climates so different that one would permit silica to pass through bauxite without combining with it, whereas the other would permit it to combine to form kaolin.

In support of the belief that some specific factor such as the activity of an organism caused bauxitization and prevented silica passing through bauxite from combining with it, the speaker described a bauxitized boulder of nepheline-syenite, from one of the bauxite mines in Arkansas, discovered and studied by Fred A. Hildebrand, which consisted essentially of the following three concentrically arranged portions: An outer envelope of high-grade bauxite with granitic texture, an inner core of less pure bauxite with granitic texture, and between the two a dense structureless layer of kaolin. These puzzling relationships were explained on the assumption that they recorded the ending of the conditions permitting bauxitization. Those silica-bearing waters moving out from the inner core that were in the outer part of the boulder escaped before bauxitization ended. But those in the kaolinized layer were caught there as bauxitizing conditions came to an end and therefore recombined with the enclosing bauxite to from kaolin.

The speaker questioned the opinion expressed by Holland in 1903 that kaolinization and bauxitization could not coexist and pointed out that to the best of his knowledge most of the bauxitized nepheline syenite of Arkansas contained some silica assumed to be combined as kaolin, and that the variation in the gibbsite-kaolin ratio with depth in the Arkansas deposits of transported beauxite indicates a progressive increase and decline in the ratio of gibbsite to kaolin with time during the period of bauxite formation.

Robert F. Black and William L. Barksdale: *Oriented lakes of northern Alaska.** The oriented lakes of northern Alaska occur in an area of more than 25,000 square miles in the Arctic Coastal Plain province. The topography, drainage, vegetation, climate, geology, and permafrost of the area are briefly described. The average range of orientation of the lakes is 13°—from N. 9° W. to N. 22° W. In any one locality the deviation from the average is commonly less than 3° and rarely over 5°. The lakes range in size from small ponds, a few tens of feet in length, to large lakes more than 9 miles long and 3 miles wide. The shapes may be described as elliptical, cigar-shaped, rectangular, ovoid, triangular, irregular, or compound. One group of lakes has a shallow shelf or under-water bench surrounding a deeper central portion. The rest are shallow throughout and the under-water profile is commonly concave upward. The major outline of the lakes is smoothly curved but in detail it is cuspate or jagged. No lacustrine beach ridges were recognized. Former lake basins, now drained, and extensions of the present lakes are indicated by shore features, lacustrine deposits, the character of polygonal ground, and vegetation. The effects of wind, vegetation, and permafrost are briefly described. The lakes are compared with the Carolina Bays and rectangular lakes in eastern U.S.S.R. Many of the lakes are believed to be the result of thawing of permafrost; others may be produced by the segmentation of uplifted lagoons. The origin of some is not known.

648TH MEETING

The 648th meeting of the Society was held at the Cosmos Club, February 12, Vice-president CARLE H. DANE presiding.

Informal communication.—Ralph L. Miller described some oolites he collected near Allentown, Pa.

Program.—HARRY H. HESS: *Major structures of the Western Pacific indicated by the bathymetric chart, Korea to New Guinea, H. O. No. 5485.*

EARL INGERSON: *Hydrothermal mineral synthesis.*

J. D. STROBELL, JR.: *Multiplex compilation of geologic maps from aerial photographs.*

649TH MEETING

The 649th meeting of the Society was held at the Cosmos Club, February 26, 1947, Vice-president CARLE H. DANE presiding.

Informal communication.—GERALD FITZGERALD.

Program.—C. E. JACOB: *Elasticity of artesian aquifers.*

T. G. PAINE: *Tectonic control of sediments during a diastrophic cycle.*

Prof. KARL MANNERFELDT: *Deglaciation of the Scandinavian Mountains.*

650TH MEETING

The 650th meeting of the Society was held at the Cosmos Club, March 12, 1947, president W. P. WOODRING, presiding.

Informal communications.—F. N. JOHNSON spoke on stream capture and WATSON MONROE discussed the weathering of glauconite.

Program.—A. P. BUTLER: *Transition from Tertiary volcanic activity to basin filling in north-central New Mexico.*

H. YAGODA: *Radiochemical techniques in the study of fine-grained radio-active minerals.*

G. A. COOPER: *The decline of paleontology.*

651ST MEETING

The 651st meeting of the Society was held at the Cosmos Club, March 26, 1947, Vice-president CARLE H. DANE presiding.

Informal communication.—C. E. JACOB spoke on the use of ground water for air-conditioning.

Program.—L. W. CURRIER: *Applied geology in the Massachusetts program.*

M. D. FOSTER: *Origin of high sodium bicarbonate water in the Coastal Plain.*

ERNEST DOBROVOLNY: *Geology applied to highway design and construction.** Geology as a phase of investigation necessary to economic road construction was recognized by the State Highway Commission of Kansas about 1935 when geological information was used in designing more satisfactory bridge footings. Refinement in the collection and presentation of methods indicated that geological data were amenable to mathematical evaluation accurately enough for the measurements required in highway engineering. This concept led to the development of a system of classification for excavation based essentially on lithology. The classification, now incorporated in the standard road specification, reads in part, "... common excavation shall consist of the removal and satisfactory disposal of all eolian, alluvial and residual materials and certain designated strata ..."; "... rock excavation shall include all firm, unaltered and unweathered cherty limestone, shaly limestone, sandy limestone, earthy and impure limestone and all other limestones including chalk beds and gypsum beds; all firm, unweathered and unaltered argillaceous, arenaceous, calcareous and carbonaceous shale, sandstone, cemented conglomerates and mortar beds . . . ."

Close association of engineers and geologists brought up questions in the field of geology which could not be answered because the necessary research had not yet been done. One outgrowth of these questions is sponsored research on problems involving kaolin minerals, mantle seepage, and construction materials.

652D MEETING

The 652d meeting of the Society was held at the Cosmos Club, April 9, 1947, Vice-president CARLE H. DANE presiding.

Informal communications.—E. F. INGERSON spoke on the use of liquid inclusions in geologic thermometry and R. R. Coates described boulders that he studied on the Aleutian Islands.

Program.—R. P. Fischer: *Origin of the Colorado Plateau vanadium deposits.** The vanadium deposits of the Colorado Plateau occur in sandstone beds of Mesozoic age. Most of them are restricted to a few stratigraphic horizons, along which they have a wide but spotty areal distribution. All the deposits have many common characteristics.

The ore minerals mainly impregnate sandstone, partly or completely filling the pore spaces of the rock. The ore bodies are irregularly shaped in plan and in section they form tabular or lenticular layers that lie nearly parallel to the bedding. These layers do not follow the beds in detail, however, and for this reason the ore in its present form can not be syngenetic but rather had to have been precipitated from solutions after the sands had accumulated.

Though the geologic environment of the vanadium deposits differs somewhat from place to place, no definite relationship has yet been demonstrated between the spatial distribution or the character of the deposits and geologic structures such as faults, folds, and igneous intrusions. Considering all factors it is difficult to rationalize the localization and character of the deposits as originating from hydrothermal or ground-water solutions that might have been introduced into the ore-bearing beds along through-going, vertical structures resulting from regional deformation or igneous activity.

Nevertheless, the habits of the ore and the location of the deposits show a close relationship to sedimentary structures and conditions that would certainly influence at one time or another the flow of solutions along or through the ore-bearing beds. Recognizing these features, and believing that mineralization after regional deformation is unlikely, it is therefore suggested that the vanadium ore was precipitated from ground waters moving along the beds during a period of active circulation shortly after the sands accumulated. Precipitation probably was caused by relatively slight changes in composition of the waters, resulting from reactions in an environment of decaying organic matter, reactions at a water table, or the mixing of two solutions.

Paul D. Krynine: *Diastrophism and the origin of sediments.*

653D MEETING

The 653d meeting of the Society was held at the Cosmos Club, April 23, 1947, President W. P. Woodring presiding. The death of C. Dwight Avery, a member of the Society, was announced.

Program.—E. N. Goddard: *A new rock color chart for field use.*

F. S. Simons: *Structure and recent activity of the Great Sitkin Volcano.*

V. P. Sokoloff: *Engineering map units in Fairfax quadrangle, Virginia.**

Introduction. The basis of this discussion is a report entitled "Engineering Soil Map of Fairfax Quadrangle, Virginia." The report was transmitted by the U. S. Geological Survey to the Public Roads Administration for analysis and criticism. The work was done in 1946 in the Engineering Geology Section of the Survey.

Problem. A major purpose of the investigation was to find out whether a usefully accurate engineering map could be produced in the office, given the required basic data. If so, reliability of the methods developed by a group of soil scientists in wartime, for the Military Geology Unit of the Survey would be attested further. A cheap and a rapid method of terrain appraisal would be then indicated, for areas having agronomic, aerial photograph, and areal geologic coverage. It was also desired to test a hypothesis that an engineering soil map of the entire area is more useful and more economic, in road building, than a series of strip maps along proposed highway locations.

The degree of attainment of these objectives will be ascertained by testers and users of the map.

Engineering map unit. The need for a somewhat nongeologic, nonagronomic map unit became apparent gradually, in the course of the present study. The concept of the engineering map unit was evolved in order to minimize the unavoidable wide range of variation in engineering properties within the geologic and the agronomic map units. It became necessary, in places, to break some geologic map units into several engineering map units. In other places, parts of several geologic (and agronomic) units had to be combined into a single engineering map unit.

The necessity for such reorganization of the basic data is illustrated by the accompanying lantern slides. A brief statement of the procedure may be of additional use in this connection.

Procedure. (1) A detailed study of land surface and drainage of the area. (2) Recognition of probability of periodic or seasonal floods in certain stream bottoms. This single consideration is believed to outweigh any other feature of such areas (texture and depth of soil, kind of bedrock, etc.). Recognition of such areas as one single engineering map unit. (3) Recognition of general physiographic features (Basin and Upland). Recognition of the probability that construction problems, soil materials, and regolith in general are not the same in the Basin as in the Upland. Separation of Basin from Upland on the engineering map. (4) Preparation of vegetation map, from the aerial photographs, in aid to a more detailed study of the quadrangle. (5) Recognition of excessively steep slope as a possible definitive feature, in certain areas, regardless of other variables (kind of bedrock, kind of soil, etc.). Slope analysis map, in aid to further study of the quadrangle. (6) Study of the areal geologic map, in conjunction with the agronomic soil map, especially in regard to possible presence of rock suited for construction and of granular construction materials. Presence of accessible hard rock noted, in some geologic map units. (7) Conclusion that the following variables merit separate consideration, in establishing and describing engineering map units in the Quadrangle: (*a*) Bedrock, as interpreted from the geologic map. (*b*) Drainage, as interpreted from the aerial photographs. (*c*) Slope, as interpreted from the slope analysis map. (*d*) Thickness of regolith, as surmised, locally, from the agronomic soil map and as derived from the general knowledge of probable depth and kind of weathering of a known kind of rock in a known kind of environment. (*e*) Sequence, texture, and physical properties of different horizons of the regolith, with a special interest in the probable presence or absence of plastic horizons, as interpreted from (*a*), (*b*), (*c*), (*d*), in the light of general knowledge of the soil-forming processes. (8) Preparation of the engineering soil map.

Conclusion. The concept of the engineering map unit, as developed in the Fairfax study, has contributed to conciseness and readability of the engineering map. The nature and usefulness of such concept, however, are not the same in different types of terrain. Further studies should be indicated, to determine the value of engineering mapping of the Fairfax type. In any case, however, it seems advantageous to depart occasionally from the purely agronomic or purely geologic approaches to engineering geologic mapping.

654TH MEETING

The 654th meeting of the Society was held at the Cosmos Club October 22, 1947, President W. P. WOODRING, presiding.

Program.—C. H. BEHRE, JR.: *Structural control of the European lead-zinc deposits of the "Mississippi Valley" type.* The purpose of this paper is to describe the geological features generally typical of "Mississippi Valley" type lead-zinc ores, with special reference to the structures that seem to have localized these ores. The paper is a greatly condensed statement of certain conclusions resulting from nine months of European study in 1937–38 while its author held a John Simon Guggenheim Memorial Fellowship. Despite the danger that generalizations too broad to be accurate may result, the general overview of any distinct type of ore deposit seems justifiable because it promises eventually to shed light on the genesis of these ores and to afford better guides for exploration than hitherto available.

Furnishing between a third and a half of the world's production of lead and zinc, the "Mississippi Valley" type is a distinguishable group of ore deposits recognized since the days of Von Cotta (1859) and Von Groddeck (1879). Their primary mineralogy is the especially characteristic criterion by which they are distinguishable: galena, sphalerite, pyrite, marcasite, calcite, and dolomite, frequently with noteworthy amounts of other carbonates, chalcopyrite, quartz, barite, and fluorite and with or without silver values. Their generally low silver content, their relative richness in lead and (or) zinc and leanness in copper, and the preponderance of carbonates as opposed to quartz gangue are especially typical. In general, the successive deposition is: calcite (usually in rhombohedral forms), pyrite (the oldest but recurrent metallic mineral), sphalerite, galena, marcasite, and late calcite (rhombohedral or scalenohedral). In many instances (Aachen, Moresnet, Silesia, Bleiberg) colloform features are prominent, and elsewhere they can be found if sought (e.g., Sardinia, Wisconsin). There is no clear evidence here that these minerals are supergene, and the chemistry of their paragenesis favors hypogene solutions.

It is in their relation to geologic structures, however, that deposits of this type show the most marked variation. Their numerousness and wide distribution in Europe make that a peculiarly favorable continent for their study, and the governing structures highly varied: Derbyshire, north England, the Midi (France), Santander, Aachen-Moresnet, the Eifel-southern Rhine, Silesia, Sardinia, Raibl (Cave di Predil), Bleiberg, Mezica, and Laurion are all well-described examples. In general, these structures are characteristic controls: (1) Relatively flat-lying beds with a few faults, usually gently dipping, zigzag in vertical section, small in displacement, and related to bedding plane movements (e.g, Silesia, north England, and our own Wisconsin-Illinois district); (2) steeply folded beds with or without transverse faults (e.g., Sardinia, Aachen-Moresnet); (3) small or large tear faults (strike-slip faults, generally transverse to the regional strike and "grain"), often associated with close folding and thrusting (Laurion (?), Bleiberg, Mezica). Normal dip-slip faults, so common with gold and copper deposits, were major ore solution channels rarely if at all, a contrast not yet explained.

The general picture is that these deposits were formed (1) at shallow depths, (2) at cool temperatures (100°C. or less), (3) from solutions that travelled noteworthy distances laterally as well as vertically, (4) where the "acid" solutions were neutralized by calcareous country rock or neutralized and cooled by descending lime-carbonate waters at ground-water level.

Samuel Zerfoss: *Some observations concerning the mechanism of crystallization.*

655th MEETING

The 655th meeting of the Society was held at the Cosmos Club November 12, 1947, President W. P. Woodring presiding. A memorial to Dr. George R. Mansfield was read by R. Richards. Dr. W. D. Johnston, Jr., presented to the Society Dr. Richardo Monges Lopez and Dr. Jenaro Gonzalez R., of the Instituto Geológico de México, and Dr. Reynaldo Saldaha de Gama, of the Universidade de São Paulo, Brazil.

Program.—J. R. Balsley: *Use of the airborne magnetometer.*

C. S. Ross: *Soil subsidence in Mexico City and its relation to failures of buildings.*

J. I. Tracey, Jr.: *Surface and subsurface structures of the Bikini reef.*

656th MEETING

The 656th meeting of the Society was held at the Cosmos Club, November 26, 1947, President W. P. Woodring presiding.

Program.—C. P. Ross: *The Belt problem.** The present study of the problem of the Belt series in Montana is a byproduct of compilation of a proposed new geologic map of the State. The series is generally regarded as of pre-Cambrian age, although a few geologists have considered it Paleozoic and there is some reason to believe that its uppermost strata may have been laid down at the same time as fossiliferous Lower Cambrian deposits in other regions. The series is thought by most geologists to have been deposited in and on the margins of a shallow epeiric sea, possibly 500 miles wide, 2,000 miles long, and connected with the Arctic Ocean.

It is here proposed to include the lower part of the Belt series in the Ravalli group, with the exception of the Prichard formation and the Neihart quartzite, the middle portion in the Piegan group, and the upper part in the Missoula group. The Prichard formation and Neihart quartzite are older than the Ravalli, and the interrelations of these two formations are unknown. All of the above names are already in use, but the definitions of them given below constitute modifications of previous usage. The name North Boulder group is here proposed for certain hitherto unnamed components of the Belt series in isolated exposures near the Jefferson River, southeast of Butte. The relations between this group and the units farther north are not clear. In addition, the Belt units along the southwestern border of the State differ in details from those farther north and in part cannot be definitely correlated at present with any of the named subdivisions of the series. Large areas in Montana that are underlain mainly by rocks of the Belt series have been studied as yet only in reconnaissance fashion. Hence the nomenclature outlined in the present paragraph, and some of the correlations suggested below are to be regarded as provisional, pending more thorough studies.

The Neihart quartzite is positively known only in its type locality near Neihart, Mont., although the name has also been applied to strata that underlie the Prichard in the Anaconda Range. At its type locality the Neihart rests on gneiss and is overlain by the Chamberlain shale. The Prichard formation, first recognized in the Coeur d'Alene region in Idaho, is exposed at intervals from the northwest corner of Montana to the vicinity of Philipsburg. In most places it consists of metamorphosed argillaceous rock with some quartzite.

The term Ravalli group is here used to include those formations of the Belt series, that overlie or are believed to overlie the Neihart and Prichard formations, and are below the Newland limestone of the Piegan group or its stratigraphic equivalent. The name Ravalli was first used by Walcott and was raised to group rank by Calkins.[4] In and near Lincoln, Mineral, and Sanders Counties, Mont., the Ravalli group contains the Burke formation, Revett quartzite, and St. Regis formation, and ranges from white quartzite to siliceous shale, mostly in subdued tones of gray, green, purple, and red. In the extreme northwestern part of Montana the maximum thickness may be 10,000 feet. In and south of Glacier National Park the Ravalli group contains the Altyn limestone, Appekunny argillite, and Grinnell argillite with an aggregate maximum thickness of more than 12,000 feet. In the park the group includes dolomite and related rocks as well as gray, green and red argillite and quartzite. In the region south of Missoula the rocks of the Ravalli are predominantly light to dark-gray quartzite and argillite. In the Little Belt Mountains the Chamberlain shale (1,500 feet thick) is at present regarded as the sole unit that can be correlated with the Ravalli group.

Above the Ravalli group is the Piegan group in which carbonate-bearing rocks predominate. The Fentons,[5] who originated the name Piegan group, would place the upper boundary of the group at the top of the Shepard formation, but it seems preferable to follow Clapp and Deiss[6] in placing it at the bottom of the Shepard, thus including that formation in the overlying Missoula group. Where the Helena limestone is recognizable, which at present is only in the general vicinity of Helena, it is regarded as the upper formation of the Piegan group. The Greyson, Spokane, and Empire shales (named in ascending order), which overlie the Newland limestone and underlie the Helena in the Helena region, may be local units or may correspond to argillaceous rocks in other regions. The term Spokane has been applied to various units outside the Helena region by different geologists, but on the basis of present knowledge all these uses of the name seem so insecure as to be inadvisable.

The principal component of the Piegan group has been variously called Siyeh, Newland, and Wallace limestone or formation and these names are retained locally. In and near the Coeur d'Alene region in Idaho and Montana the Wallace formation, which in that region is the only representative of the Piegan group, is of diverse composition. It includes more or less calcareous shale and sandstone and impure, generally dolomitic limestone. It is distinctive in that it contains the only significant amounts of calcareous and dolomitic material in the Belt series of that region and most of the formation shows closely spaced banding. It also contains characteristic segregation structures. There is reason to believe that locally the formation, which is 17,000 feet thick near Libby, Mont., will eventually be subdivided into smaller map units. From the northwestern border of the State to the vicinity of Philipsburg the rocks of the Piegan group are similar to those just described, except that the carbonate content probably increases southeastward. In Glacier Park the Piegan group, as here defined, consists largely of massive dolomite and dolomitic limestone with interbedded argillite, quartzite, oolite, and mud breccia; maximum reported thickness is 5,400 feet. The carbonate rocks are banded in a manner similar to that of the Wallace and segretation structures and algal remains are present. Numerous subdivisions of the group in this area have been suggested. In the general vicinity of Helena, including the Belt Mountains, the Newland limestone, which constitutes the lower part of the Piegan group there, is an argillaceous, dolomitic limestone with some calcareous argillite. Segregation structures are not conspicuous. Above the Newland are three formations composed of gray, brown, red, and green shale, followed upward by the Helena limestone, an impure, fine-grained, in part dolomitic limestone with plentiful algal remains and segregation structures.

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[4] Calkins, F. C., *A geological reconnaissance in northern Idaho and northwestern Montana.* U. S. Geol. Survey Bull. 784: 38. 1909.

[5] Fenton, C. A., and Fenton, M. A., *Belt series of the North: Stratigraphy, sedimentation, paleontology.* Bull. Geol. Soc. Amer. **48:** 1890–1900. 1937.

[6] Clapp, C. H., and Deiss, C. F., *Correlations of Montana Algonkian formations.* Bull. Geol. Soc. Amer. **42:** chart and p. 691. 1931.

The Missoula group includes all of the Belt series above the Piegan group in all localities where the Piegan is recognizable. In southwestern Montana some of the Belt rocks lithologically resemble the Missoula but correlation on the basis of present data is speculative. In northwestern Montana and adjacent parts of Idaho the Missoula group is represented by the Striped Peak and Libby[7] formations. In and near Glacier Park the Shepard, Kintla, and other units[8] are included in it. In the vicinity of Missoula, its type locality, the group is described as containing 18,000 feet divided into five formations.[9, 10] In parts of the region around Helena the Marsh shale is the sole representative, but to the north other units appear and in the Saypo quadrangle four formations have been distinguished within the group.[11] In general, the Missoula group consists of argillaceous and siliceous clastic rocks, with subordinate calcareous beds. The prevailing color is red to purple, but green beds are present in most exposures and gray rocks are locally plentiful.

Strata of the Belt series here named the North Boulder group extend eastward along and north of the Jefferson River from the vicinity of North Boulder River, from which the name for the group is taken, to a point northeast of Sappington. The group is thought to rest directly on the pre-Belt complex of metamorphic rocks and lies without angular discordance beneath the Flathead quartzite (Middle Cambrian). Direct evidence concerning the age equivalence of the group is lacking. It may be equivalent in age to some part of the Missoula group or to part of that group and part of the Piegan group. The North Boulder group has coarse conglomerate at the base, with arkose, some conglomerate, and sandy and silty strata above. The total thickness is 6,000 feet or more. Subdivisions have not been shown on any published map but available information[12, 13, 14, 15] suggests that there are three or, more probably, four subdivisions of formational rank in this group.

JOSIAH BRIDGE: *Geology of the Palau Islands.*

T. STADNICHENKO: *Browsing through Russian literature on geology and allied science.*

657TH MEETING

The 657th meeting of the Society was held at the Cosmos Club, December 10, 1947, Vice-president CARLE H. DANE presiding.

The President announced that last January he had appointed a committee consisting of T. B. NOLAN, MARCUS GOLDMAN, and H. S. LADD to select the two best papers presented before the Society during 1947. Dr. Nolan was then called on to present the prizes. The first prize of $25 was unanimously awarded to C. E. JACOBS; the second prize of $10 was awarded to FRANK S. SIMMONS.

Program. Presidential address by WENDELL P. WOODRING: *Central America land bridge and sea lane.*

55TH ANNUAL MEETING

The 55th Annual Meeting was held immediately following the 657th regular meeting. The reports of the Secretaries, Treasurer, and Auditing Committee were read and approved. Officers for the year 1948 were then elected:

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[7] GIBSON, RUSSELL, *Geology and ore deposits of Libby Quadrangle, Montana.* Bull. U. S. Geol. Survey in prep. 1947.

[8] FENTON, C. A., and FENTON, M. A., *Belt series of the North: Stratigraphy sedimentation, paleontology.* Bull. Geol. Soc. Amer. **48:** 1890–1900. 1937.

[9] CLAPP, C. H., and DEISS, C. F., *Correlations of Montana Algonkian formations.* Bull. Geol. Soc. Amer. **48:** correlation table and pp. 690–691. 1931.

[10] LANGTON, C. M., *Geology of the northeastern part of the Idaho batholith and adjacent regions in Montana.* Journ. Geol. **43:** fig. 3. 1935.

[11] DEISS, CHARLES, *Stratigraphy and structure of southwestern Saypo quadrangle, Montana.* Bull. Geol. Soc. Amer. **54:** 211–218. 1943.

[12] PEALE, A. C., *Three Forks Folio.* U. S. Geol. Survey, Geol. Atlas of the United States, Folio 24. 1896.

[13] TANDEY, WILFRED; SCHAFER, P. A.; and HART, L. H., *A geological reconnaissance of the Tobacco Root Mountains, Madison County, Montana.* Montana Bur. Mines and Geol. Mem. 9. 1933.

[14] BERRY, G. W., *Stratigraphy and structure at Three Forks, Montana.* Bull. Geol. Soc. Amer. **54:** p. 6. 1943.

[15] PERRY, E. S., Personal letter of Oct. 24, 1947.

President: W. W. RUBEY.

Vice-Presidents: J. S. WILLIAMS and K. E. LOHMAN

Secretary: DONALD DOW (for two years)

Treasurer: CHARLOTTE A. MARSH

Council: R. P. BRYSON, E. C. CABOT, HELEN CANNON, D. H. DUNKLE, GEORGE O. GATES

The Society nominated W. W. RUBEY to be a Vice-President of the Washington Academy of Sciences for the year 1948.

GEORGE T. FAUST, *Secretary.*

Obituaries

NELSON HORATIO DARTON, internationally known geologist and member of the U. S. Geological Survey for 50 years, died on February 28, 1948, after a brief illness, at his home in Chevy Chase, Md. He was born on December 17, 1865, in Brooklyn, N. Y. At the age of 14 he quit public school to become an apprentice in his uncle's pharmaceutical establishment, where by diligent application and study he acquired a considerable reputation as a practical chemist. Mineral specimens in his uncle's cabinet aroused his interest in the rocks around New York City, which prompted many field trips and caused him to prepare a card catalog of papers on the geology of that region. Out of these activities grew an acquaintance with professional geologists, in particular with the noted G. K. Gilbert, of the U. S. Geological Survey, who persuaded him to join the Survey in 1886. Darton's first project was the compilation of a bibliography of North American geology, the forerunner of a valuable series of volumes.

Field work presently took Darton into many parts of the Eastern States, where he investigated water resources and prepared many maps. Similar water, coal, gas, oil, and other geologic studies occupied him for many years in the Western States, Mexico, and Venezuela. In much of this work he was a pioneer, having to make his own topographic bases for geologic mapping. The results of all this indefatigable travel and work are concentrated in more than 200 publications, including 26 Geologic Folios, 7 Professional Papers, and 27 Bulletins of the U. S. Geological Survey. Many of these publications became famous, some almost achieving the rank of best-seller, as, for example, *Story of the Grand Canyon* and *Guidebook of the Western United States: The Sante Fe Route*. He regarded U. S. Geological Survey Professional Paper 32, *Preliminary report on the geology and underground water resources of the Central Great Plains*, as one of his best papers. His last work deals with the geology of the District of Columbia.

In 1922 Darton received the Sc.D. degree from the University of Arizona; in 1930 the Daly gold medal of the American Geographical Society; and in 1940 the Penrose medal of the Geological Society of America. Among his many scientific affiliations, he was an honorary member of the American Association of Petroleum Geologists, an original Fellow of the Geological Society of America, a founder and president of the Geological Society of Washington, a founder of the Association of American Geographers, and a founder of the Washington Academy of Sciences.

Dr. Darton had a gracious personality. As a public speaker he enlisted the hearers' attention not only by his orderly presentation of interesting facts but also by his excellent command of language and a pleasing platform manner. His last appearance was in an address to the Geological Society of Washington on February 11, 1948.

He was buried in Mount Olivet Cemetery in Washington, D. C. Surviving him are his wife, one daughter, and two sons.

ROLAND W. BROWN.

HORACE TERHUNE HERRICK, one of the country's leading authorities on the industrial utilization of agricultural commodities, and special assistant since January 1, 1946, to the chief of the Bureau of Agricultural and Industrial Chemistry, died at his home in Washington, D. C., on October 7, 1948, after a long illness. He had retired because of disability less than two months earlier.

Mr. Herrick had been a leader in research on the utilization of agricultural commodities since he entered Government service in 1926. As Assistant Chief of the Bureau of Agricultural Chemistry and Engineering from 1938 to 1942 he was in charge of planning, building, and staffing the four large regional research laboratories devoted to finding new uses and wider markets for farm products. From 1942 to 1946 he was director of the Northern Regional Laboratory in Peoria, Ill. The fermentation research at this Laboratory, which was a continuation of work initiated under Mr. Herrick's direction in 1927 when he was chief of the Color and Farm Waste Division, helped to make possible the commercial production of penicillin during World War II.

In 1946 Mr. Herrick returned to Washington as special assistant to the chief of the Bureau of Agricultural and Industrial Chemistry, of the Agricultural Research Administration, successor to the Bureau of Agricultural Chemistry and Engineering. His wide personal acquaintance with industrial users of agricultural materials made possible the maintenance of close cooperative relations with manufacturers and food processors who benefited from the Bureau's research results and assisted in commercial tests of new products and processes developed in its laboratories.

Previous to entering the United States Department of Agriculture, Mr. Herrick had more than 15 years of experience in the manufacture of industrial chemical products, such as illuminating gas, dyes, and fine and heavy chemicals. He was a lieutenant-colonel in the Chemical Warfare Service Reserve between World War I and World War II.

Born in Brooklyn, N. Y., in 1887, Mr. Herrick was the older son of James Frederick Herrick, telegraph editor of the *New York World*, and Christine Terhune Herrick, writer and author. He was a nephew of the late Albert Payson Terhune, well-known writer of dog stories. Mr. Herrick was a prolific writer and the author of numerous articles on fermentation and the industrial utilization of agricultural commodities. After attending Lawrenceville School in Lawrenceville, N. J., he received the A.B. degree from Princeton University and the degree of Chemical Engineer from Columbia University. He was a member of the American Chemical Society, the Cosmos Club of Washington, the American Institute of Chemical Engineers, the Washington Academy of Sciences, the Chemical Society of Washington, Sigma Xi, and Alpha Chi Sigma.

Mr. Herrick is survived by his widow, the former Cecile Debouy, and one daughter, Miss Cecile Herrick, both of Washington; also by two sons, Snowden Terhune and Horace Terhune, Jr., by a former marriage to Elinore Morehouse Herrick, and by one brother, James F. Herrick, a writer.

Joseph Alfred Ambler, Department of Agriculture organic chemist and authority on sugar chemistry, died suddenly on October 6, 1948, in New Orleans, La. He was born on June 30, 1889, in Danbury, Conn., and was a graduate of Yale University, where he received the bachelor degree in 1910 and the doctorate in 1913. Before entering government service, he taught chemistry for three years at Acadia University in Wolfeville, Nova Scotia.

Dr. Ambler had 30 years' service in the Department of Agriculture, which he entered in 1917 as a chemist in the Color Laboratory of the Bureau of Chemistry, Washington, D. C. He headed this laboratory from 1922 to 1925 and made important contributions to fundamental knowledge of coal-tar dyes, particularly those used in food products. He was also associated with the development of methods for producing furfural from corncobs. After a year's absence from the Department, Dr. Ambler returned to the Bureau of Chemistry's Carbohydrate Research Division in Washington. He conducted fundamental investigations in this division from 1926 to 1937 on the minor constituents of sugar beets, sorgo, and sugarcane. His work in determining the effects of contaminants in commercial sugar products was outstanding.

In 1940, the Carbohydrate Research Division was combined with the Food Research Division to form the Division of Agricultural Chemical Research, in which Dr. Ambler continued his research on carbohydrates. Since 1943, this division has been housed in the bureau's Southern Regional Laboratory at New Orleans. Dr. Ambler was made chief of the Organic Chemical Section of the division in July 1948. His recent investigations were concerned primarily with the recovery and utilization of aconitic acid from sorgo and sugarcane. He was co-inventor of the basic process for extracting aconitic acid from these crops; also he contributed to development of a method for direct production of itaconic acid from calcium aconitate.

For a number of years, during his residence in Washington, Dr. Ambler lectured on the chemistry of carbohydrates and proteins at George Washington University. He was a member of the American Chemical Society, Alpha Chi

Sigma, Sigma Xi , and the Washington Academy of Sciences. He is survived by his wife, Mrs. Flossie Belle Holloway Ambler, and by a son, George C. Ambler, of Falls Church, Va.

Harold Watson Murray died on June 15, 1948, at the age of 41 years in the midst of an active professional career and at the full tide of his scientific endeavors. The great loss to his family and friends is also sadly felt by his associates who cooperated with him in his hydrographic and oceanographic studies. His knowledge and understanding of the configuration of the continental shelves and ocean bottoms had only in part been presented in the monographs he authored. His writings bear witness alike to that patient and indefatigable zeal in independent research and to the pioneering spirit which he brought to a field that has so recently begun to yield its secrets. Had he lived, his future contributions in the field of oceanography would certainly have been of immeasurable value. May we, who are keenly aware of the value of his research, continue probing the mysteries of the lands beneath the seas.

Mr. Murray was born in East Avon, N. Y., on October 6, 1906, son of Charles Howard and May Schultz Murray, and together with his sister, Gladys S., lived his early years in the town of his birth and in Pottsgrove, Pa. His family subsequently moved to Milton, Pa., where he returned frequently for short vacation periods in recent years.

After graduation from Milton High School he entered Bucknell University and in 1929 received his bachelor's degree in civil engineering. He then accepted a position with the U. S. Coast and Geodetic Survey and was chief of the Hydrographic Surveys Section at the time of his death.

His interest in hydrography and oceanography is attested by his further graduate studies at George Washington University. His early oceanographic work in the Survey was in association with Paul A. Smith and A. C. Veatch in the delineation of the continental shelf on the Atlantic coast. He was well equipped for these scientific studies, as his was a keen and analytical mind, and he pursued each newly discovered oceanographic feature from the first indication of its existence to its complete portrayal. The results of some of his studies were presented in three monographs.

Mr. Murray was a fellow of the Geological Society of America, a member of the American Geophysical Union, the Philosophical and Geological Societies of Washington, the American Congress on Surveying and Mapping, and the Washington Academy of Sciences. He represented the Coast and Geodetic Survey on the subcommittee on sedimentation, Federal Inter-Agency River Basin Committee. He was a Presbyterian, a Mason, and an officer in Trinity Lodge F.A.A.M., and was a member of Albert Pike Consistory, M.R.S., and Almas Temple, Washington, D. C.

His research work was his chief hobby, as his able and conscientious nature seemed to provide a driving force almost exclusively in that direction. His daily work in the Coast and Geodetic Survey furnished the basic material which could be studied and assembled into a portrayal of previously unrevealed submarine topography. His spare time at home was thus spent to a considerable extent in pursuit of his life work. He took up aviation and needed only a few hours of solo flying to qualify for his pilot's license. But again, it is felt he wished to fly in order to obtain an additional perspective of land formations in connection with a better understanding of submarine topography.

In addition to his widow, Mabel F. Murray, he is survived by two young sons, H. Martin and Harold W., Jr.

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George F. Jordan.

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MEDICINE.—*Morbidity from cancer.*[1] Harold F. Dorn, National Cancer Institute. (Communicated by Frederick D. Rossini.)

Approximately 3,500,000 children were born in the United States during the calendar year 1948. If existing morbidity rates from cancer and mortality rates from all causes of death except cancer should remain unchanged, 700,000, or one-fifth of these children, will develop cancer during their lifetime. To state this fact in another way, the probability that a newborn child will develop cancer during his lifetime is one out of five.

The chances at birth of developing cancer are about 17 percent greater for females than for males; the chances are 228 per 1,000 for females compared with 195 per 1,000 for males. This difference becomes smaller with increasing age, so that by age 50 the chance of developing cancer is approximately equal for each sex. After that age, although the chances of developing cancer decrease for each sex, they decrease more rapidly for women than for men with the result that the male rate is 40 percent higher than the female rate by age 80.

It is estimated that at least one-third of a million new cases of cancer are diagnosed annually in the United States. In addition, an equal number of cases, previously diagnosed, are still under observation or treatment, so that all together around two-thirds of a million persons with cancer receive medical care at some time during each year.

Is the number of persons who develop cancer larger now than formerly? Reliable morbidity statistics of cancer have been available only within the past ten years, and so the answer to this question must be partly estimated. The National Cancer Institute at the present time has under way a study to determine changes in morbidity from cancer during the past decade. As soon as the results of this study are available a more definite answer can be given to this question.

In spite of the lack of accurate morbidity statistics, it is almost certain that the number of persons in the United States today with cancer is larger than the number twenty years ago. The total population now is 27,000,000 greater than twenty years ago. In addition, the proportion of the population in the older age groups has been increasing steadily. Since the probability of developing cancer increases rapidly with increasing age, the aging of the population will result in a larger number of cases of cancer, even though the morbidity rate per 1,000 persons at each age remains unchanged.

It is easy to overlook the effects of the remarkable increase in the average length of life that has taken place since the beginning of the present century. Under the mortality conditions existing in 1900, one-half of the births in that year would live to age 58. Under the mortality conditions existing in 1940, one-half of the births of that year would live to age 70.

This increase in the proportion of the persons who live to advanced ages has resulted in an increase in the number of persons with cancer and other diseases of late adult life. With the mortality rates prevailing in 1900, about 5 percent, or one out of every twenty newborn children, would be expected to die from cancer. By 1940 about 12 percent, or one out of every eight newborn children, would be expected to die from cancer. Thus the probability of eventually dying from cancer has more than doubled since 1900. But this increase is due to a decrease in the death rate from causes other than cancer

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[1] Received January 31, 1949.

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as well as to some increase in the death rate from cancer.

In addition to the increase in the number of cases of cancer resulting from the increase in the size of the population and from the fact that more people now live to the ages when cancer is most frequent, has there been any increase in the number of cases of cancer which can be attributed to changes in environmental or other factors? A definite answer can not be given to this question. Although very little is known today about specific causes of cancer in human beings, most of the causes that have been identified are environmental in character. This does not mean that genetic factors may not be important, but their precise role in human cancer is not known at the present time. There is considerable evidence that many chemicals and other materials used in industry are capable of causing cancer. Quantitative evidence is not available, but it is believed by some that the number of persons with occupationally induced cancer has increased in recent years.

One of the striking features of cancer is that it is found most frequently among elderly people. This should not blind us to the fact that cancer occurs at every age. Among males cancer does not occur very frequently until age 40. After this age, morbidity rates increase so rapidly that by age 75 they are about 14 times higher than the rates at 40 years of age. Morbidity from cancer becomes important at an earlier age among females than among males. Cancer is about as frequent among females at 30 years of age as it is among males of 40 years of age.

Nearly three-fourths of all cancer in females and one-half of all cancer in males develop in either the digestive or genital systems. Among females the breast and genital organs are attacked most frequently. Out of every 100 women who develop cancer 50 will have cancer of the genital system or breast and 25 will have cancer of the digestive system. Among males in about 40 out of every 100 who develop cancer the growth originates in the digestive system. The respiratory and urinary systems are relatively infrequent sites of cancer in both males and females.

The higher incidence of cancer among females is due entirely to the greater susceptibility of the female genital system to cancer. If we exclude cancer of the genital system, the incidence rate of cancer in males is about 60 percent higher than the rate for females.

Why should the female genital system be attacked by cancer so much more frequently than the male genital system? There are many theories, but little objective evidence bearing on this question. It is thought by some that cancer of the cervix may result from lacerations and tears during childbirth. However the importance of this factor is not known. There is some statistical evidence that cancer of the genital organs is more frequent among married women than among single women. On the other hand, cancer of the breast is more frequent among single than among married women. Married women who have borne children have a lower death rate from cancer than married women who have not borne children. The mere performance of a marriage ceremony almost certainly has nothing to do with the development of cancer. Physiological changes associated with childbearing or lack of childbearing undoubtedly are related to the greater frequency of cancer of the uterus in married women and of cancer of the breast in single women. The relationship between such changes and the development of cancer is not understood at the present time.

The only other important sites where cancer develops as frequently in women as in men are the brain, thyroid, liver, and intestines. The brain, thyroid, and liver are relatively infrequent sites of occurrence of cancer. The intestines, however, are a fairly common site of origin.

It was once thought that Negroes were relatively immune from cancer. This belief probably arose from the failure of cancer to be diagnosed among Negroes. The incidence rate among females is about 10 percent higher for whites than for Negroes; among males the rate for Negroes is only about one half that for whites. There seems to be no good reason to account for the relatively low morbidity rate among Negro males except failure to receive medical care.

There is one racial difference in susceptibility to cancer that tends to cause a higher cancer illness rate among whites than among Negroes. Dermatologists and clinicians long have believed that light-skinned persons are more likely to develop cancer of the skin than are persons with more pigmentation. The morbidity rates for cancer of the skin of whites and Negroes support this belief. The incidence rate for cancer of the skin is about seven times greater among whites than among Negroes.

In contrast to the definitely lower susceptibility of Negroes to cancer of the skin is the greater susceptibility to cancer of the genital organs especially among females. Even though the incidence rate for all forms of cancer is only about one-half as great for Negro as for white males, the rate for cancer of the genital organs is approximately the same. Cancer of the uterus is 60 percent more frequent among Negro than among white women. The situation is reversed for cancer of the genital organs other than uterus. The prevalence rate for cancer of the breast is 50 percent higher and that for other sites such as vagina, vulva, and ovaries is 85 percent higher for white females.

It has been suggested that the high incidence of cancer of the genital organs in Negro males and of cancer of the uterus in Negro females may be related to venereal disease. Syphilis and other venereal diseases are known to be much more frequent among Negroes. It has not been clearly established, however, that the existence of syphilis increases susceptibility to cancer, so that, at the present time, the high incidence of cancer of certain of the genital organs among Negroes can not be satisfactorily explained.

Cancer attacks proportionately more people living in the South than in any other region of the United States. The number of new cases per 100,000 population per year is nearly 50 percent higher for the white population in the South than in the North. This is in striking contrast to the general belief that cancer is less common in the South. This belief arises from the fact that mortality rates actually are lowest in the South and highest in the Northeast and Pacific Coast States.

The high illness rate from cancer in the South is due primarily to the relatively larger number of cases of skin cancer in that region. Since skin cancer can be readily cured, mortality rates from cancer in the South are lower than in the North, even though the illness rate for all forms of cancer is higher.

Skin cancer is nearly five times as frequent in the white population in the South as in the North and about two and one-half times as frequent as in the West. Although Negroes are less susceptible to skin cancer than whites, the illness rate from skin cancer is twice as high among Negroes living in the South as among Negroes in the North.

There is considerable circumstantial evidence that the high incidence of skin cancer in the South is related to exposure to sunlight. In addition, clinical observations have shown that cancer of the skin occurs principally on exposed areas of the body and that it is more frequent among outdoor workers such as farmers and seamen. Laboratory experiments also have demonstrated that mercury arc radiation and natural sunlight will cause cancer in rats and mice. Although the mechanism of tumor production by radiation is not clearly understood, the available evidence of the relationship between sunlight and skin cancer points strongly to a causal connection between the two.

GEOLOGY.—*A newly discovered type of clay deposit in Utah.*[1]

CHARLES B. HUNT, U. S. Geological Survey, A. S. CREAMER, National Bureau of Standards, and JOSEPH J. FAHEY, U. S. Geological Survey.

A type of clay deposit, recently discovered as a result of systematic regional geological surveys in Utah, may prove to be a valuable source of raw material for brick and structural clay products. The deposits were first discovered in Utah Valley, where the U. S. Geological Survey has been conducting a regional survey and study. Subsequent reconnaissance proves that the deposits are widely distributed in Utah and extend into adjoining states. In a cooperative study, tests of samples of the clay by the National Bureau of Standards indicate that the clay has certain qualities that are generally lacking in most of the clays in the region.

The deposits that have been the principal sources for clay in Utah are chiefly of two kinds: beds of clay interstratified with the fill in the valleys in western Utah and shale formations in the older rocks that occur in or near the mountains and plateaus. The newly discovered source is a clay that formed as an ancient soil.

Field occurrence.—The ancient soil that may prove to be a valuable source of clay was formed during those glacial or interglacial periods that preceded the existence of Lake Bonneville. This is a critical fact in prospecting for commercial deposits because the clay obviously will be found only at those places where the land surface has been preserved since pre-Bonneville time without being either eroded or buried by other sediments.

The ancient soil, where preserved in its entirety, is deep. The clay occurs in the upper part of the soil and in places is 10 feet thick. Beneath the clay are 20 or 30 feet of strongly lime-enriched, weathered parent material; the top of this lime-rich zone would form the bottom of pits that might be opened in the clay.

The clay comprising the upper layer of the old soil is practically free of lime but does contain considerable iron oxide. The most common clay mineral is of the hydromica type and there is a minor quantity of montmorillonite; much more study of the mineralogy of the deposits is needed before it will be possible to generalize about the mineral or chemical composition of the deposits.

The texture of the clay, or its content of sand aggregate, varies considerably depending on the parent rock from which the old soil was formed. The soil is known to have formed from limestone, shale, granitic rocks, lavas, and mixtures of these. The parent rocks, except for their quartz or other resistant minerals, were completely altered to clay by the soil-forming process. Where, for example, the soil developed on a shale formation, very little sand aggregate remains and more than 90 percent of the clay can be washed through a 325-mesh sieve. On the other hand, where the soil developed on gravel or other deposits containing much quartz, this material remains with the clay. Sixty to seventy percent of this kind of clayey material can be washed through a 325-mesh sieve.

Because the deposits are remnants of a land surface that has been modified by erosion since the deposits were formed, their size and shape vary widely. The thickest and most extensive deposits occur on smoothly rounded upland surfaces (Fig. 1) where several feet of clay may extend over a number of acres. Some individual deposits already known contain many tens of thousands of cubic yards of clay. Undoubtedly there are many more deposits, some of which probably are larger than the few observed thus far. Although the individual deposits are not large, the total reserves available are believed to be immense.

Chemical and optical properties.—The essential constituents, other than the alkalies, of the three samples that have been studied, are listed in Table 1. The high content of iron oxide made index measurements of the clay minerals impossible. A thermal analysis by George T. Faust and an X-ray powder examination by Joseph M. Axelrod,

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[1] Published by permission of the Director, U. S. Geological Survey. Received February 1, 1949.

TABLE 1.—PARTIAL CHEMICAL ANALYSES OF SAMPLES OF CLAYS FROM SOME ANCIENT SOILS IN UTAH (J. J. FAHEY, ANALYST)

	Sample 1	Sample 2	Sample 3
	Percent	*Percent*	*Percent*
Loss on ignition	6.78	6.88	6.83
SiO_2	67.37	69.61	66.07
Al_2O_3	13.86	12.65	15.54
Fe_2O_3	5.10	4.58	6.02
MgO	1.67	1.51	1.87
CaO	0.02	0.02	0.02
TiO_2	0.75	0.70	0.96
MnO	0.003	0.003	0.003

Sample 1, old soil on oldest of glacial moraines by Dry Creek, above Alpine. Sample 2, old soil on fanglomerate from near reservoir in Traverse Range ± 2 miles northwest of Alpine. Sample 3, old soil formed on Manning Canyon shale, south side of Provo Canyon, by Pole Canyon road ± 2 miles from Provo Canyon Road.

both of the U. S. Geological Survey, indicate that the clay is predominantly hydromica. A minor quantity of montmorillonite is present.

Examined under the petrographic microscope sample No. 1 was found to contain approximately 20 percent quartz and 20 percent orthoclase, sample No. 2 about 25 percent quartz and 20 percent orthoclase and sample No. 3 about 20 percent quartz and 15 percent orthoclase.

Ceramic properties.—The suitability of the clay in the ancient soil for ceramic uses was investigated at the National Bureau of Standards. Data were obtained on the physical properties of samples of the clay taken from the three deposits listed in Table 1. In determining the properties, tests were made of grain size, tempering water, drying and firing shrinkage, firing range, and color of fired specimens. The results are summarized in Table 2.

Despite the difference in source of the samples of these old soil clays, certain similarities were found in the quality of the raw clays as well as in the properties of fired specimens. This clay is characterized by large amounts of fine material (66 to 93 percent), while the remaining material is of a sandy nature. Approximately the same quantities of tempering water (26 to 29 percent) resulted in good workability of the three samples of clay. A relatively long heating range of about 980° to 1080°C., or cones 06 to 03, was accompanied by small changes in shrinkage, and by a variation of shades of red and brown colors of the specimens.

The results of the tests indicate that these clays should be satisfactory for the manufacture of building brick and structural clay products.

Some aids in prospecting for commercial deposits.—The mode of origin of these clay deposits furnishes the most useful clues for prospecting for commercial deposits. Smoothly rounded upland surfaces are the most favorable localities. Depending on the proportion of aggregate desired in the clay, prospecting would be guided by the kind of parent rock under these upland surfaces.

Prospecting would be inexpensive because the clay occurs at the surface with no more than a few inches of recent rubble or humus above the clay. Hand augers are adequate for determining the quality, extent, shape, and thickness of a deposit.

In general the lime-rich zone that lies beneath the clay and that would form the floor of a development pit is undulatory and slopes toward the present valleys. Rarely can a level floor be expected beneath the clay. The slope of the floor, however, generally

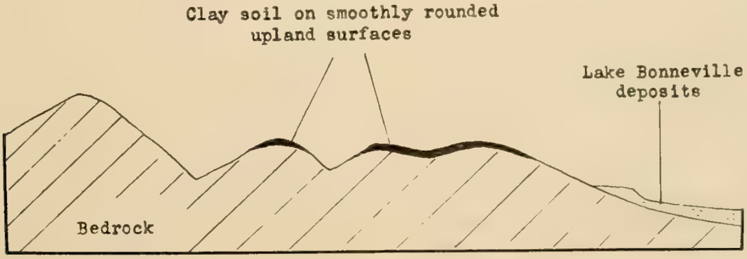

FIG. 1.—Diagrammatic section showing how ancient clay soil is preserved as erosion remnants on smoothly rounded upland surfaces in parts of Utah.

is much less steep than the present land surface so the deposits generally thicken in a direction away from the present valleys.

Listed below are a few of the most accessible localities in Utah where different kinds of deposits may be examined. These localities are cited merely so that persons interested in prospecting for this type of clay can acquaint themselves with some of the varieties that are available because of differences in the parent rocks; the particular deposits are not necessarily of commercial extent.

Clay containing considerable aggregate, in part pebbly, can be found in the eastern part of the Traverse Range immediately northwest of Alpine. This clay developed from gravel deposits containing pebbles of limestone, quartzite, granite, and latitic lavas. Similar high-aggregate-bearing clay that formed directly on bedrock formations of limestone, quartzite, and latitic lavas occurs in the western part of the Traverse Range.

Clay that contains very little aggregate, and that formed on a shale formation, is well exposed along the Pole Canyon Road on the south side of Provo Canyon.

Clay formed on a limestone formation is exposed in road cuts along U. S. Highway 91 between Brigham City and Wellsville. Clay formed on rhyolitic flows occurs in the Tintic district at the southwest base of Packard Peak about 1½ miles northwest of Eureka.

Many other localities are known; those listed are merely readily accessible examples of some of the varieties of the clay and they are not to be regarded as the most promising localities. Indeed, all the mountains in central and western Utah, the Uinta Mountains, and the high plateaus of central and south-central Utah are favorable areas for prospecting for these clay deposits. Similar areas in the adjoining parts of Colorado, Wyoming, Idaho, and Nevada appear to be equally promising.

TABLE 2.—CERAMIC TESTS OF SAMPLES OF CLAY FROM SOME ANCIENT SOILS IN UTAH

Clay sample No.	Sieve analysis				Tempering water	Shrinkage during drying	Total shrinkage after heating 1000°C/hr.	Color after heating 1000°C./hr.	Total shrinkage after heating 1100°C./hr.	Color after heating 1100°C./hr.
	On 100-mesh sieve	On 200-mesh sieve	On 325-mesh sieve	Through 325-mesh sieve						
	percent	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*		*percent*	
1	19.2	8.2	6.5	66.1	29.2	8.4	13.3	Brown-red	7.5	Dark red brown
2	11.15	10.3	9.15	69.4	26.1	9.2	12.5	Brown-red	7.1	Dark red brown
3	3.9	1.0	2.2	92.9	29.4	—	10.2	Salmon	12.4	Dark red

PALEONTOLOGY.—*Genotypes of some Paleozoic Bryozoa.*[1]

HELEN DUNCAN, U. S. Geological Survey. (Communicated by JAMES STEELE WILLIAMS.)

In the course of investigations of the literature on some Paleozoic Bryozoa, several species commonly considered to be genotypes were found to be inacceptable under the International Code of Zoological Nomenclature. Inasmuch as some of these erroneous designations can not be corrected incidentally in studies now in progress, the required changes and their taxonomic significance are discussed here. The seven genera involved are: *Batostomella*, *Dichotrypa*, *Meekopora*, *Nematopora*, *Taeniodictya*, *Trematella*, and *Worthenopora*.

With the exception of *Trematella* Hall, the genera affected were proposed by E. O. Ulrich between 1882 and 1890. Some of the confusion is traceable to delay in the publication of his monographic study of the Paleozoic Bryozoa that appeared in volume 8 of the Geological Survey of Illinois. The literature indicates that other paleontologists knew of Ulrich's manuscript genera and species. In fact, Ulrich (1890a: 679–680) voluntarily transmitted diagnoses of his unpublished genera, their intended genotypes, and lists of species included in each genus to S. A. Miller, who published all this information in his *North American geology and palaeontology*, which appeared in 1889, a year before the Geological Survey of Illinois volume. Most of the species Ulrich intended to make types of his new genera were *nomina nuda* in 1889 when Miller published the generic diagnoses. Fortunately, many of the lists in Miller consisted exclusively of undescribed species. Genotype designations for most of Ulrich's genera were therefore validated in 1890. However, the species lists for three genera—*Dichotrypa*, *Meekopora*, and *Worthenopora*—each contained a single previously described species. As the intended genotypes were *nomina nuda* and therefore unavailable in 1889, these three genera are monotypical, the one valid species listed for each in Miller's work being the type.

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[1] Published by permission of the Director, U. S. Geological Survey. Received February 17, 1949.

Conditions of original publication necessitate recognition of species other than those ordinarily cited as genotypes for *Batostomella*, *Nematopora*, and *Taeniodictya*. The fact that Ulrich first published these names prior to 1890 in connection with species he discussed or described restricts the selection of types to those species originally included in the genera.

According to Opinion 7 (On the interpretation of the expression "n.g., n.sp." under Article 30A), the genotype of *Trematella* Hall was fixed by a technicality of expression employed in the original publication. Consequently the species hitherto regarded as type of the genus is inadmissible.

Although these erroneous designations have been ignored or overlooked for more than half a century, their perpetuation, whether intentional or inadvertent, certainly should not be continued. Except in the case of *Batostomella*, application of Article 30 of the Code for the recognition of genotypes does not seem to make any material difference in the systematic interpretation of the genera. It would be unnecessary therefore, if not impossible, to recommend suspension of the Rules in the interests of stability of nomenclature.

The revised concept of *Batostomella*, based on the genotype selected by Miller, has rather extensive taxonomic implications. As now interpreted, the genus must be referred to another family of trepostomatous bryozoans and is therefore inacceptable zoologically as the type of a family characterized by structural features hitherto called "batostomellid." Owing to original misconceptions, a heterogeneous assemblage of genera had been assigned to the Batostomellidae, and the family stood in much need of revision even before present investigations demonstrated the name to be nomenclaturally inapplicable. On morphologic grounds, the taxonomic problem can be solved most practically by referring the early Paleozoic "batostomellid" genera to other families and by erecting a new family for the later Paleozoic "batostomellids." The family Stenoporidae is therefore defined to include the stenoporoid and leioclemoid types that formerly comprised the main elements of the Batostomellidae. The probable relationships of "batostomellid" genera that do not fall within the limits set for the new family are discussed so far as existing knowledge of them can be evaluated, and if possible these genera are assigned elsewhere in the classification.

In addition to the demonstrably erroneous designations here discussed, inconsistencies discovered in standard generic synonymies aroused doubt regarding the status of the genotypes commonly cited for *Lyropora*, *Ptylopora*, and *Streblotrypa*. As far as it has been possible to check, their type species appear to have been selected in accordance with Article 30 of the Code. However, the synonymies for these three genera should be revised to include at least the significant citations that bear on the recognition of their type species.

The 10 genera for which genotypes are clarified or corrected as a result of this investigation are taken up in alphabetical order on the following pages.

Special acknowledgment is made for advice on nomenclatural problems generously given by Dr. J. Brookes Knight, of the U. S. National Museum. Access to type specimens from the American Museum of Natural History was arranged through the kindness of Dr. A. R. Loeblich, Jr., of the U. S. National Museum.

STATUS OF BATOSTOMELLA ULRICH, 1882

No type species was designated for the genus *Batostomella* at the time of original publication (Ulrich, 1882: 140–141). Four species and one variety, all previously described, were included in the genus, however; and two of these, *Chaetetes gracilis* Nicholson ex James (Nicholson, 1874a: 504) and *Calamopora tumida* Phillips (1836: 200), were described superficially. On a subsequent page of the same article (Ulrich, 1882: 154), a diagnosis of *Batostomella* was published but no type was named. Three undescribed (and unnamed) species were mentioned also by Ulrich (1882: 141) as belonging in the genus, but these presumably were not published until several years later (Ulrich, 1890a: 432–436) when he described six new species. Ulrich's generic diagnosis of 1890 (1890a: 375) is accompanied by the statement that the types of *Batostomella* are "*B. spinulosa* n. sp., and *B. gracilis* Nicholson." Between 1882 and 1890 and especially after 1890, Ulrich's concept of the genus changed, for several of the species originally included and two of those described in 1890 were placed in other genera.

When Miller (1889: 294) published a diagnosis of *Batostomella* with a list of seven species, six of which were *nomina nuda*, he designated *Chaetetes gracilis* Nicholson as genotype. Inasmuch as Ulrich's original concept of *Batostomella* as well as his 1890 interpretation of the genus was definitely based in part on *Chaetetes gracilis*, Miller's designation of this species as genotype not only fulfills the requirements of Article 30 of the Code that the type must be selected from the originally included species, but also seems to be the only practical selection that could have been made.

Subsequently Ulrich (1893: 228) assigned *Batostomella gracilis* to *Homotrypella* Ulrich (1886a: 83) and commented that the genus *Batostomella* must "be restricted to the Devonian and Carboniferous species originally intended as types." Nickles and Bassler (1900: 185) appear to be responsible for assigning the species to *Bythopora* Miller and Dyer (1878: 6), a genus antedating *Batostomella* by four years. If this generic assignment is accepted, *Batostomella* is to be considered a junior synonym of *Bythopora*. A study of the type species of these two genera, however, has raised much doubt that *Chaetetes gracilis* Nicholson is congeneric with *Bythopora fruticosa* Miller and Dyer (1878: 6–7), a junior objective synonym of *Helopora dendrina* James (1878: 3), the genotype of *Bythopora*. The present location of Nicholson's type or types is unknown, but specimens of *Bythopora gracilis* from the Maysville of Cincinnati, Ohio, in the collections of the U. S. National Museum, which agree with Nicholson's descriptions in all respects, exhibit wall structure and other characters that are typical of heterotrypid genera. This observation is strongly supported by Nicholson's descriptions and figures of what was presumably the original type material (Nicholson, 1881: 125–128). On the other hand, the wall structure of *Bythopora dendrina* (James) and several other closely related species is practically indeterminate owing to the minute size of the zoaria, obliquity of the zooecia, narrowness of the mature zone, and the consequent difficulty of preparing tangential sections adequate for study. The group of species typified by *B. dendrina* is believed to be generically distinct from the more robust species exhibiting heterotrypid wall structure, such as *Chaetetes gracilis* Nicholson and *Chaetetes meeki* James (1878: 1), whose characters are not readily comparable with those of typical species of *Bythopora*. It is therefore here considered that *Batostomella* is a valid genus of lower Paleozoic Heterotrypidae.

During the summer of 1948, after the writer's investigations of these nomenclatural problems and their taxonomic ramifications had been largely completed, copies of a paper containing a discussion of the status of *Batostomella* arrived in this country. Crockford (1947: 33–34) has reviewed the nomenclatural problem and pointed out that *Batostomella spinulosa* Ulrich is inadmissible as a genotype. Miller's designation of *Chaetetes gracilis* as type of the genus apparently did not come to her attention. Inasmuch as she did not have access to the specimens and some of the literature bearing on the *Batostomella* problem, Crockford did not attempt to correct the existing confusion, though she discussed the rejected synonyms of *Batostomella* and their inadequacy as replacing names and mentioned the need for renaming the family.

NOMENCLATURE AND TAXONOMY OF THE LATE PALEOZOIC "BATOSTOMELLID" BRYOZOA

For taxonomic purposes it is not particularly unfortunate that the name *Batostomella* must be either submerged as a junior synonym or, which is more likely, employed for a genus of early Paleozoic heterotrypid bryozoans. Paleontologists working on the Bryozoa (Ulrich, 1890a: 365; Condra, 1902: 342; 1903: 47–48, 98–99; Girty, 1907: 43; 1913: 316; 1915: 323–326; Moore, 1929: 13; Nikiforova, 1933a: 24–25) have commented on the difficulty in setting the limits of the genus and in determining the relationships of species assigned to it with those identified as belonging to other genera, some of which are not even classified in the same family or order. Some of the late Paleozoic species hitherto assigned to *Batostomella* Ulrich may be referred to other genera such as *Megacanthopora* Moore (1929: 10–13), *Dyscritella* Girty (1910: 193), *Stenopora* Lonsdale (1844: 161–162), *Stenodiscus* Crockford (1945: 21), *Rhombopora* Meek (1872: 141), and possibly other rhomboporoids.

Two genera, *Geinitzella* Waagen and Wentzel (1886: 875, 880–882) and *Batostomellina* Vinassa de Regny (1921: 227), generally have been held to be the same as *Batostomella*. The possibility of using these names for late Paleozoic "*Batostomella*" therefore must be considered. As type specimens of the genotypes are not known to have been sectioned in connection with earlier studies, our knowledge of these genotypes is based on material identified by other workers as belonging to the species.

Status of Geinitzella.—The genus *Geinitzella* has been a source of much nomenclatural and taxonomic confusion. Most paleontologists have assumed that its genotype was *Coralliolites columnaris* Schlotheim, 1813, a species referred to *Stenopora* Lonsdale, 1844, by King (1850: 28–29). It is highly probable that many of the specimens identified with Schlotheim's species do not belong in it. In fact, Schlotheim himself must have assigned more than one species to his *Coralliolites columnaris*. Schauroth (1854: 542–543) commented on this, but subsequent authors (Geinitz, 1861: 113–114; Dybowski, 1876: 6–7; 1877: 68–69) regarded Schauroth's conclusion as erroneous. In the original publication, however, Schlotheim mentioned the species as probably occurring in the Grauwackenschiefer (Schlotheim, 1813: 29) with other fossils that are presumably of Devonian age. On a subsequent page (Schlotheim, 1813: 59–60), *Coralliolites columnaris* was discussed as a fossil of the Zechstein, and this is the citation which King, Geinitz, Dybowski, and later authors all give as the original description (if it can so be construed) of the species. Schlotheim (1813: 74) also included *Coralliolites columnaris* in the faunal list for the Jurakalkstein. As is to be expected in paleontological work of this early period, Schlotheim distinguished his species on gross characters and lumped specimens from rocks of widely different ages into the same species. It is impossible to tell from the original publication just what was included in *Coralliolites columnaris*. The passage cited (Schlotheim, 1813: 59) as the original description merely states that the species is a characteristic type of coral superficially resembling and very easily confounded with the stems and columnals of crinoids. Schlotheim further commented that these forms correspond for the most part with the coral type illustrated by Picot de Lapeirouse T. X. F. 6. The figure cited (Lapeyrouse, 1781: pl. 10, fig. 6) is that of a Cretaceous rudistid. A study of Schlotheim's original "types" would be needed in order to determine the exact systematic position of the fossils he included in *Coralliolites columnaris*. No mention was found in the literature dealing with this species that the revisers had examined Schlotheim's material, and it is not known whether his "types" are extant.

King (1850: 28), in first assigning *Coralliolites columnaris* to *Stenopora*, and Geinitz (1861: 113), in extending the application of this species, appear to have included a good many forms that do not belong in the same species and some that probably do not belong in the same genus. Geinitz (1861: 114–115) further complicated matters by distinguishing several "varieties" of *Stenopora columnaris*. Examples of these "varieties" were furnished to Waagen and Wentzel (1886: 880–883), who identified some of the same forms among the specimens they described as *Geinitzella columnaris* from the Permian of the Salt Range. Waagen and Wentzel (1886: 880) stated that their genus *Geinitzella* was "founded" on *Stenopora columnaris* but did not specifically designate this species as genotype. Although most subsequent workers have considered this species to be the type, no one seems to have unequivocally designated it as such until 1935 (Bassler, 1935: 117). In the meantime, Lee (1912: 152) had selected "*Geinitzella ramosa* [sic] var. *incrustans*" as the genolectotype. The trivial name "*ramosa*" is obviously a *lapsus*, inasmuch as Lee referred to the description and figures of *Geinitzella columnaris* var. *incrustans* and name "*ramosa*" applies to another variety distinguished by Geinitz. The nomenclatural status of varieties has been a matter of dispute, some specialists contending that a variety is not equivalent to a subspecies, the lowest nomenclatural category recognized in the present Code, and therefore is to be ignored for purposes of nomenclature. The revised Code presumably will clarify this situation by providing for the nomenclatural recognition of varieties described before 1950. Lee's selection therefore, as Crockford (1947: 34) has remarked, "must be accepted," and the genus *Geinitzella* must be interpreted on the genolectotype *Stenopora columnaris* var. *incrustans* Geinitz (1861: 114) = *Geinitzella incrustans* (Geinitz).

Even though *Geinitzella incrustans* is accorded recognition as the genolectotype, the taxonomic significance of the genus has yet to be determined. Previous interpretations of the structural characters of this species (Lee, 1912: 152; Bassler, 1929: 61; 1935: 117; Crockford, 1947: 34) seem to have been based entirely on Waagen and Wentzel's figures (Waagen and Wentzel, 1886: pl. 106, figs. 5, 6) of specimens from the Salt Range and not on Geinitz's types. Waagen and Wentzel's description and figures are inadequate for determination of generic characters, especially because no tangential section was figured and it is not possible to tell whether the tubular structures between the zooecia, shown in the longitudinal sections, are mesopores or acanthopores. Bassler (1929: 61; 1935: 117) apparently interpreted these small tubes as mesopores, inasmuch as he stated (1929) that the specimens "may represent the group for which *Dyscritella* is now employed" and (1935) that this species "seems to be the incrusting portion of a *Batostomella* without diaphragms." Crockford (1947: 34) observed that these figures show irregularly thickened zooecial walls and concluded that Waagen and Wentzel's *Geinitzella columnaris* var. *incrustans* should probably be referred to *Stenopora*. My impression is that the figures show part of a ramose stenoporoid "incrusted" with a layer of renewed growth of the same species. The feature of renewed growth in one or more layers is rather common among the stony bryozoans, including ramose and bifoliate species as well as those having massive and laminar zooaria, and certainly is not of sufficient zoological significance to differentiate a "variety" (in the sense of subspecies).

In any event, the genus should be interpreted not on specimens from the Salt Range but on Geinitz's types of *Stenopora columnaris* var. *incrustans* from the Zechstein of Germany. Unfortunately Geinitz's type specimens apparently have not been subjected to study by modern methods, and the original descriptions and figures (Geinitz, 1861: 114, pl. 21, figs. 1–6, 8, 19) are not adequate for interpretation. It is probable that more than one species is represented among the figured specimens. Dybowski's investigation (Dybowski, 1876, 1877) of the species was based on specimens in the collections of the University of Dorpat that he had identified with Geinitz's figures (Geinitz, 1861: pl. 21, fig. 19, 19A) of a specimen deposited in the Dresden Museum. Dybowski's figured specimen may be identical with Geinitz's species, but this cannot be verified by examination of the illustrations. It seems advisable, however, to here designate the specimen figured by Geinitz on plate 21, figure 19, as the lectotype of *Geinitzella incrustans* (Geinitz).

Assuming that Dybowski's material is identical with the lectotype, it is difficult to decide whether the species should be referred to *Stenopora* or recognized as belonging to a distinct genus—*Geinitzella*. Dybowski's figures appear to depict an incrusting stenoporoid with relatively abundant mesopores. *Stenopora* is commonly described as having few mesopores. It is impossible to tell whether the lectotype here chosen has mesopores, hence the uncertainty as to whether Dybowski correctly identified his specimens. Species of *Stenopora* differ considerably in the development of mesopores. In specimens of the genotype, *S. tasmaniensis* Lonsdale (1844: 161–162; see also Bassler, 1941: 173–174, figs. 5, 6), mesopores are absent or extremely rare. On the other hand, a good many of the species of *Stenopora* described and illustrated by Crockford (1943, 1945) in recent years are characterized by a moderate number of mesopores, especially in the monticules. As none of these species are incrusting or laminar forms, Crockford's studies furnish no data on the comparative development of mesopores in zooaria of this type. Among the incrusting stenoporoids described from the late Paleozoic of North America are two species that seem to be correctly identified as *Stenopora*. *S. spinulosa* Rogers (1900: 1–2) is described as having a few small mesopores, whereas *S. granulosa* Girty (1908: 128–129) is characterized by a moderate number of mesopores. Condra (1903: 41) reported that the walls of *S. spinulosa* are not moniliform. Girty's species from the Permian of the Guadalupe Mountains has definite though few monilae in the zooecial walls (Girty, 1908: pl. 19, fig. 1c). In general, beading appears to be very much more distinct in the thinner-walled stenoporoids, and it is to be expected that thick-walled species, such as *S. spinulosa*, will not exhibit conspicuous monilae.

In light of the foregoing observations, Dybowski's figured specimens of *Stenopora columnaris* [var. *incrustans*] from the Lower Zechstein near Gera belong with the taxonomic unit now called *Stenopora*. Until the lectotype of Geinitz's species can be demonstrated to possess a different combination of characters, the name *Geinitzella* should be referred to the synonymy of *Stenopora*. Future work, of course, may show *Geinitzella* to be applicable for a subgenus of incrusting and laminar Stenoporas. At present, however, differentiation based on these zooarial habits does not seem to be advisable. As long ago as 1891, Etheridge (p. 48) expressed the opinion that the distinction between *Geinitzella* and *Stenopora* seemed to be a very artificial one. His observation is certainly supported by the published illustrations and later studies.

The suggestion (Bassler, 1929: 61) that *Geinitzella* may be a senior synonym of *Dyscritella* merits no serious consideration, for there is not the slightest indication that in the type species of *Geinitzella* mesopores even approach the abundance characteristic of the leioclemoid genus *Dyscritella*. The specimens illustrated by Waagen and Wentzel (1886: 883, pl. 113, figs. 3, 4) as "*Geinitzella columnaris* var. *ramosa multigemmata*" may indeed prove to be a species of *Dyscritella;* but for the present at least, the other specimens Waagen and Wentzel figured as *Geinitzella crassa* (which most certainly is not specifically identical with *Stenopora crassa* Lonsdale, 1845: 632) and varieties of *G. incrustans* may conveniently be assigned to *Stenopora*.

Other species, mostly from Russia and Asia, that have been assigned to *Geinitzella* probably will be found to belong to *Stenopora*, *Stenodiscus*, *Rhombotrypella* Nikiforova (1933a: 36), or other stenoporoid genera. *Geinitzella chinensis*, described by Girty (1907: 42; 1913: 315, pl. 28, figs. 9–14) from the Permian of China, is a *Stenodiscus* with mesoporelike acanthopores. Likewise, the three species, *Batostomella* (*Geinitzella*) *hayasakai*, *B.* (*Geinitzella*) *yunnanensis*, and *B.* (*Geinitzella*) *manchuriensis*, recently described by Yabe and Sugiyama (1942: 406–414) from the lower Permian of China are probably *Stenodiscus*. The wall structure of these species is not discussed and the figures are very inadequate, but indications are that this is the most logical generic assignment.

Status of Batostomellina.—This name, introduced by Vinassa de Regny (1921: 227) for a subgenus of *Batostomella*, has never gained acceptance. Bassler (1935: 54, 55) considered it to be a junior synonym of *Batostomella*, for the genotype, *Trematopora granulifera* Hall (1852: 154, pl. 40A, figs. 9a–e), had been referred to *Batostomella* by Nickles and Bassler (1900: 180) and later was redescribed and refigured by Bassler (1906a: 28–29, pl. 13, figs. 1–5, pl. 24, figs. 10, 11, pl. 25, figs. 11, 12).

In connection with the present investigation, thin sections were prepared of Hall's types of *Trematopora granulifera*. From among the cotypes included in American Museum of Natural History Cat. No. 1757, the specimen figured by Hall (1852: pl. 40A, fig. 9e) and refigured by Bassler (1906a: pl. 24, fig. 10) is here selected as lectotype of the species. Thin sections show the type to be identical with the topotypes (U. S. Nat. Mus. no. 35517) figured by Bassler (1906a: pl. 13, figs. 1–5).

A study of the excellent sections prepared by Bassler shows that the general features of *Trematopora granulifera* are accurately described and figured. However, examination at higher magnifications than those used for Bassler's illustrations has revealed some features not hitherto described. First, the wall structure of this species is not comparable to that of the later Paleozoic "Batostomellidae." The zooecial walls are rather vague and not distinctly laminated and appear to be more like those of *Trematopora tuberculata* Hall (1852: 149), the genotype of *Trematopora* Hall (1852: 149). The possibility was considered that this similarity was deceiving and due to conditions of preservation, inasmuch as both *T. tuberculata* and *T. granulifera* occur in the Rochester shale at Lockport, N. Y.; but other species from the same locality and horizon do not support that interpretation. Both *Trematopora tuberculata* and *T. granulifera* have very narrow mature zones, lack diaphragms in the zooecia, and possess abundant mesopores, which are closed at the surface. In *T. tuberculata* the mesopores are beaded, whereas in *T. granulifera* they are so obscured by acanthopores that it is impossible to be sure whether diaphragms are completely absent.

The most distinctive features of *T. granulifera*, however, are to be noted in the acanthopores. These structures are extremely abundant and near the surface completely obscure the mesopores. In comparison with the zooecia, the acanthopore tubes are relatively large, closed at the surface but hollow through most of their length and lined with minute mural spines. These tiny spines give a ragged hazy appearance to the walls in the mature region. Bassler's figures (Bassler, 1906a: pl. 13, figs. 4, 5) give some impression of this condition, but the cause was apparently not observed or described.

As a result of the present study, *Batostomellina* Vinassa de Regny should be restored as a generic name for lower Paleozoic trepostomatous bryozoans. The genotype appears to be allied to *Trematopora*; and, for the time being, the genus may be assigned to the Trematoporidae, a family that no doubt needs revision along with the other trepostomatous families established more than half a century ago.

The three other species assigned to *Batostomellina* by Vinassa de Regny (1921: 227) most certainly are not related to *B. granulifera* (Hall). *Dyscritella ambigua* Lee (1912: 181, pl. 16, figs. 11, 12) may be correctly assigned to *Dyscritella*—in any event it appears to be a leioclemoid or a stenoporoid bryozoan. *Bythopora parvula* (James, 1878: 3; see also Bassler, 1906: 22, pl. 3, figs. 11, 12, pl. 5, fig. 4) appears to be a *Bythopora* though it possesses some cryptostomatous features. *Batostomella interporosa* Ulrich and Bassler (1913: 270–271, pl. 45, figs. 1, 2, pl. 48, fig. 5) resembles the type of *Dyscritella* in many respects, and for the time being may be considered a delicate species of that genus.

Aside from the genotype, the writer does not know of any described species that should be assigned to *Batostomellina*. It is not expected that the name will be applicable for any species of "batostomellid" bryozoans from the late Paleozoic.

Systematic position of "Batostomella" spinulosa.—Much of the difficulty experienced by previous workers in dealing with the genus "*Batostomella*" and the group of genera included in the family "Batostomellidae" is directly attributable to Ulrich's faulty interpretation of *B. spinulosa*. In the collections of the U. S. National Museum are two slides of the figured sections (Ulrich, 1890a: pl. 75, figs. 1d, e, f), one bearing the tangential and longitudinal sections illustrated in figures 1d and 1e and the other the longitudinal section shown in figure 1f. Sections 1d and 1e were made presumably from the same specimen, but there is no way of knowing whether section 1f came from the same fragment. In section 1f, diaphragms are lacking in the zooecial tubes. Unfortunately there is no tangential section to compare with the tangential on the other slide. The sections figured as 1d and 1e were partly shattered in mounting, and the longitudinal especially is too thick for microscope examination. Rather abundant diaphragms are shown in Ulrich's figure 1e. In the immature region, at least, calcite cleavage cracks were misinterpreted as diaphragms. A few diaphragms are present in the transition zone and mature region of some zooecia, but most of the diaphragms illustrated in this figure are cracks or strands of dense zooecial deposits. The diaphragms shown in some mesopores on the left side of figure 1e cannot be identified in the section. In the description of this species Ulrich (1890a: 434–435) reports the mesopores to be moderately abundant. Actually they are relatively few, very inconspicuous, and mostly no larger than the acanthopores.

As Ulrich's figured sections of this species are inadequate for study and interpretation of its characters, and as a type for this species has never been named, a lectotype (U.S.N.M. no. 114344) has been chosen from the specimens labeled by Ulrich as his cotypes. This specimen has been sectioned and without doubt is identical with the species figured by Ulrich (1890a: pl. 75, figs. 1d, 1e).

The newly made thin sections of the lectotype amply confirm the preceding statements about the occurrence of diaphragms. None are present in the mesopores or in the immature region. A very few zooecia have a single diaphragm in the transition zone. A longitudinal section through an older part of the zoarium shows that approximately half the zooecia contain one or two, occasionally three, diaphragms in the mature region. A longitudinal section through a younger part of the zoarium exhibits very few diaphragms; in fact they are absent in most of the zooecia. It seems possible that diaphragms may have been developed in the ephebic growth stages, an explanation that would account for their variable distribution in different parts of the zoarium. The longitudinal section lacking diaphragms that was figured by Ulrich (1890a: pl. 75, fig. 1f) may well have cut the growing end of a branch.

A tendency toward intermittent thickening of the zooecial walls in the transition zone and early mature region is to be observed, especially in the older part of the zoarium. Other specific characters were adequately described and figured by Ulrich and need not be repeated here.

Many of the Carboniferous species that have been assigned to "*Batostomella*" and that seem to be rather closely allied to "*B.*" *spinulosa* possess features, such as intermittently thickened or moniliform walls and perforated diaphragms, that are commonly held to be stenoporoid. Some of these species perhaps should be more correctly assigned to *Stenopora* Lonsdale, *Tabulipora* Young (1883: 154; see also Lee, 1912: 149), *Stenodiscus* Crockford, and allied genera. At the present state of our knowledge, it would be difficult to formulate a definition for a genus that would encompass the late Paleozoic species generally referred to "*Batostomella*" without transgressing limits set for several other genera. The erection of a new genus for the group of species more or less typified by "*B.*" *spinulosa* does not seem wise at this time. In the event a new genus is defined, it would be well to avoid naming "*B.*" *spinulosa* or any of the other species described by Ulrich in 1890 as genotype, because we have only vague locality data for these species, and their geologic horizons are somewhat indefinite. It has not been possible to examine and evaluate all the species described from North America, the number of which is insignificant in comparison with the known but undescribed species and the abundant material still unstudied, which is expected to increase our information on this group manifold. Until comprehensive studies can be made of skeletal structures, variation, and evolutionary trends in the stenoporoids, rhomboporoids, and "bastostomellids," the introduction of a single new generic name for this poorly understood group will serve no useful purpose. For the present it will suffice to retain most of the described species in "*Batostomella.*"

Revised classification of the "batostomellid" Bryozoa.—Whether the name *Batostomella* is recognized for an early Paleozoic genus of probable heterotrypid affinity or held to be a synonym of *Bythopora*, the family name Batostomellidae proposed by Ulrich (1890a: 341, 375; see also Miller, 1889: 290) is no longer tenable for those genera commonly described as stenoporoid or leioclemoid. Some might argue that the family name should become accordingly Bythoporidae; but *Bythopora* Miller and Dyer, *Eridotrypa* Ulrich (1893: 264), and some other genera, based on genotypes of Ordovician age and known exclusively from the lower Paleozoic, are not in the least typical of the large group of genera now included in the family, nearly all of which are confined to later rocks. Both *Bythopora* and *Eridotrypa*, which are similar in many ways, appear to be closely allied to the Heterotrypidae, though revision may show the need for recognizing a separate family for these two and some other related lower Paleozoic genera.

The problem of basic relationships was confused originally by Ulrich's inclusion of two very different types of bryozoans in his genus *Batostomella*, the type of the family. One of his "types," "*B.*" *spinulosa*, was obviously related to species grading into the stenoporoids and rhomboporoids, whereas the actual type, *B. gracilis* (Nicholson), superficially resembles some species of *Bythopora.* For this reason, no doubt, *Bythopora* was originally placed in the family along with *Batostomella, Stenopora, Anisotrypa* Ulrich (1883: 275–276), *Callotrypa* Hall and Simpson (1887: xvi), and *Leioclema* Ulrich (1882: 141). After Ulrich (1893: 228) referred *Batostomella gracilis* to *Homotrypella*, a monticuliporoid bryozoan, and *B. simulatrix* Ulrich (1890a: 432–433), another Ordovician species, to *Eridotrypa* (see Ulrich, 1893: 265), the premises for assuming there was a systematic gradation from the early to the late Paleozoic "batostomellid" genera were nullified. Even Ulrich (1893: 265) recognized this when he wrote of *Eridotrypa*, "The systematic position of the genus, though in a measure doubtful, is probably intermediate between *Homotrypa* (compare *H. similis* Foord) of the Monticuliporidae, and *Bythopora* Miller and Dyer, of the Batostomellidae. Because of the absence of cystiphragms it will be best to embrace the genus provisionally in the latter family."

Though Ulrich realized originally that he had included an "incongruous assemblage" of genera in his family Batostomellidae and indicated a few years later that his ideas about relationships and phylogeny had changed considerably, he apparently felt that published knowledge was too scant to substantiate a radical redistribution of genera and revision of the family classification. In any event, *Bythopora* and *Eridotrypa* were left in the family Batostomellidae, as it was then understood, and have been retained there until the present in spite of our greatly increased knowledge of the later Paleozoic Trepostomata and their relationships.

Of the other genera Ulrich included in the family, *Stenopora*, *Anisotrypa*, and *Leioclema*, though representing rather diverse structural types, appear to be related through a series of transitional genera, and consequently their inclusion in the same supergeneric division can be reconciled. The systematic relationships of *Callotrypa* are uncertain, because its genotype has never been critically studied. Likewise, *Trematella* Hall (1886: expl. pl. 25), which Ulrich (1893: 264) considered to be a synonym of *Batostomella*, has never been adequately studied and its taxonomic position is undetermined.

Since 1893 a large number of genera based mostly on Devonian and post-Devonian species have been assigned to the family "Batostomellidae." Two Ordovician genera, *Esthoniopora* Bassler (1911: 259) and *Orbipora* Eichwald (1856: 92), have been called primitive stenoporoids, but they differ so obviously from the typical late Paleozoic forms that they may well belong elsewhere in the classification. *Koninckopora* Lee (1912: 152) has for a genotype a species that has been demonstrated (Wood, 1943: 205–221) to be an alga and is therefore eliminated. Left in the family are more than a score of genera that seem to be closely related to divisions we may conveniently designate the *Stenopora* and *Leioclema* groups. As a few genera are transitional between the two main structural divisions, the establishment of two families is not feasible. Inasmuch as the name Batostomellidae is inapplicable, a new name is needed. The family Stenoporidae is here proposed, not as an exact substitute for the family Batostomellidae as it commonly has been applied, but as a taxonomic division that will include the *Stenopora* and *Leioclema* types of trepostomatous bryozoans.

A point of priority is involved in proposing the name Stenoporidae for a bryozoan family. Waagen and Wentzel (1886: 873, 875) originally introduced the subfamily Stenoporinae as a division of the Monticuliporidae (a name early students used generally for the stony bryozoans) several years prior to Ulrich's publication of the family name Batostomellidae. Ulrich apparently was unaware of Waagen and Wentzel's work when he prepared the manuscript for the Geological Survey of Illinois Volume VIII. Etheridge (1891: 31) adopted the subfamily Stenoporinae as a convenient taxonomic division, but it seems to have been ignored by paleontologists ever since even though many genera are commonly referred to as stenoporoids. The name *Stenopora* has been widely used for many stenoporoid species, especially in earlier work before the generic distinctions now recognized were observed. Though now restricted, the genus is one of the best established and most characteristic of the group, and it is most appropriately chosen as type of the family.

STENOPORIDAE, n. fam.

Definition.—Trepostomatous Bryozoa characterized by distinctly laminated, generally amalgamate zooecial walls. Zooaria of variable habit—ramose, massive, incrusting, frondescent, and bifoliate.

Stenoporoid genera distinguished typically by irregularly thickened walls in the mature region, the thickening being intermittent in primitive types and trending to conspicuous beading in advanced forms. Mesopores not abundant in most genera. Acanthopores commonly very abundant and conspicuous. Diaphragms generally complete in primitive forms; commonly perforated, incomplete, or lacking in more advanced genera.

Leioclemoid genera characterized typically by rather uniformly thickened and comparatively thin zooecial walls in the mature region. Mesopores abundant, generally completely isolating the zooecia. Acanthopores generally abundant but, owing to the excessive number of mesopores, usually less conspicuous than in the stenoporoids. Diaphragms variable in occurrence and type; complete or absent in the mesopores; typically complete in the zooecia, but perforated or lacking in some genera and species.

Remarks.—A few genera, which appear to be transitional or highly specialized forms, possess some characters that are diagnostic of the stenoporoids and others that are distinctly leioclemoid. For example, certain species that have been assigned to *Leioclema* and allied genera have intermittently thickened or beaded walls and others have perforated diaphragms. On the other hand, several predominantly stenoporoid genera possess mesopores in an abundance comparable to that of the leioclemoids.

A few of the genera in the following list are included in the family Stenoporidae with considerable doubt. Typical *Anisotrypa* (some of the species assigned to this genus probably are more properly referable to *Tabulipora*), *Callocladia*, *Coeloclemis*, and *Syringoclemis* all have some cryptostomatous features.

As outlined in the preceding discussion, *Batostomella*, *Bythopora*, *Eridotrypa*, *Esthoniopora*, and *Orbipora* appear to have no close relationships with the Stenoporidae. *Koninckopora* is not a bryozoan. *Callotrypa* and *Trematella* are at present too poorly known to be used taxonomically, and their genotypes will have to be studied before family assignments can be made. *Lioclemella* possesses none of the diagnostic characters of the Stenoporidae, and its systematic position is uncertain.

Of the genera listed, only *Leioclema* is at present accommodating Ordovician and Silurian species. A study of the thin sections of most of the lower Paleozoic species that have been assigned to *Leioclema* casts much doubt on the appropriateness of referring most, if not all, of these species to the genus. It is difficult to reconcile the wall structure and various other features exhibited by these earlier Paleozoic forms with the morphology of the Lower Carboniferous genotype *Leioclema punctatum* (Hall, 1858: 653). One can only conclude that the Ordovician and Silurian species are examples of homeomorphy and were derived from several different stocks. Some of these species appear to have relationships with *Nicholsonella* Ulrich in Miller (1889: 313), others with *Hallopora* Bassler (1911: 325), and still others with such monticuliporoids as *Homotrypella* Ulrich (1886a: 83) and *Atactoporella* Ulrich (1883: 247). Careful study of the lower Paleozoic species now included in *Leioclema* will probably demonstrate the need for establishing several genera in order to avoid a polyphyletic genus.

Range.—Silurian?, Devonian-Permian.

Genera of the Stenoporidae.—

Amphiporella Girty, 1910.
Anisotrypa Ulrich, 1883.
"*Batostomella*" Ulrich, 1890 (non *Batostomella* Ulrich, 1882).
Calacanthopora Duncan, 1939.
Callocladia Girty, 1910.
Chondraulus Duncan, 1939.
Coeloclemis Girty, 1910.
Diplostenopora Ulrich and Bassler, 1913.
Dyoidophragma Duncan, 1939.
Dyscritella Girty, 1910.
Eostenopora Duncan, 1939.
Leeporina Vinassa de Regny, 1921.
Leioclema Ulrich, 1882 (objective synonym: *Lioclema* Ulrich, 1896; subjective synonym?: *Thallostigma* Hall, 1883).
Liopora Girty, 1915.
Megacanthopora Moore, 1929.
Microcampylus Duncan, 1939.
Pycnopora Girty, 1910.
Rhombotrypella Nikiforova, 1933.
Stenocladia Girty, 1910.
Stenodiscus Crockford, 1945.
Stenophragma Munro, 1912.
Stenopora Lonsdale, 1844 (subjective synonyms: ?*Tubuliclidia* Lonsdale, 1845[2]; ?*Geinitzella* Waagen and Wentzel, 1886; *Ulrichotrypa* Bassler, 1929).
Stenoporella Bassler, 1936.
Stereotoechus Duncan, 1939.
Syringoclemis Girty, 1910.
Tabulipora Young, 1883.
Tabuliporella Nikiforova, 1933.
Trachytoechus Duncan, 1939.

DICHOTRYPA ULRICH IN MILLER, 1889

Although Ulrich (1890a: 386) designated *D. foliata* Ulrich (1890a: 499) as type of the genus, the prior publication of a generic diagnosis in Miller (1889: 300) with a list of the species Ulrich intended to include in the genus, all but one of which were *nomina nuda*, makes that designation invalid. *Fistulipora flabellum* Rominger (1866: 122) was the only included species for which a description had been published in 1889. Therefore, under Article 30 *Dichotrypa* is a monotypical genus taking *D. flabella* (Rominger) as its type. So far as can be determined, the recognition of this species as genotype does not create a zoologic problem, and the generic concept is essentially unchanged.

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[2] The name *Tubuliclidia* was originally published (Murchison and Verneuil, 1844: 497–498) in connection with two undescribed species listed in a faunal chart. It was therefore a *nomen nudum* and had no status (under the present Code and Opinion 53) until the following year, when Lonsdale (1845: 631) noted that he preferred to use the name *Stenopora* for the genus. *Tubuliclidia* has been cited in some synonymies of *Stenopora*, and it seems to have been assumed that *S. tasmaniensis* Lonsdale (see Bassler, 1935: 222) was the genotype. This species, however, was not one of the two originally assigned to *Tubuliclidia*, and moreover it came from a different continent. According to current interpretation of the Code, *S. tasmaniensis* is inadmissible as type. Unfortunately neither *Stenopora spinigera* Lonsdale (1845: 632) nor *S. crassa* Lonsdale (1845: 632), which were originally included in *Tubuliclidia*, have been carefully studied, and the possibility exists that these two species do not belong to *Stenopora*. Inasmuch as the original figures and description of *Stenopora crassa* = *Tubuliclidia crassa* indicate good possibility of its being a *Stenopora*, this species is here designated type of the genus *Tubuliclidia* in the hope that the name can be demonstrated eventually to be a subjective synonym if the revised Code does not provide for rejecting it as a junior objective synonym.

LYROPORA HALL, 1857

Hall (1857: 179) originally distinguished *Lyropora* as a subgenus of *Fenestella* and described three species but did not designate a genotype. Subsequent authors (Ulrich, 1882: 150; Claypole, 1883: 32; Hall, 1885: 37; Waagen and Pichl, 1885: 773; Ulrich, 1886: 5) who recognized and discussed this genus failed to select a genotype. Therefore Miller's designation (1889: 312) of *Lyropora lyra* Hall (1857: 179) as type of the genus must stand. Ulrich (1890a: 583) considered *L. lyra* to be a slightly modified form of *L. subquadrans* Hall (1857: 180) differing so little from that species that it could not even be distinguished as a variety. Nickles and Bassler (1900: 311) list the *L. lyra* form as *Lyropora subquadrans-lyra* (Hall). Bassler (1935: 142) cites *Fenestella* (*Lyropora*) *subquadrans* Hall, 1857, as type of the genus. Whether referring *L. lyra* to synonymy with *L. subquadrans* is a legitimate procedure can be determined only from a study of the type specimens, which apparently were not examined by Ulrich or later workers. In any event, the type citation should be *Fenestella* (*Lyropora*) *lyra* Hall, a species which may be identical with *Fenestella* (*Lyropora*) *subquadrans* Hall. Under the circumstances, it would seem more appropriate to consider *L. subquadrans* a possible synonym of *L. lyra*.

MEEKOPORA ULRICH IN MILLER, 1889

Ulrich's designation (1890a: 383) of *Meekopora eximia* Ulrich (1890a: 483–484) as type of this genus is invalid owing to the fact that Miller (1889: 312–313) originally published the generic diagnosis in connection with a single previously described species, *Fistulipora? clausa* Ulrich (1884: 47). *Meekopora* is therefore a monotypical genus having *M. clausa* (Ulrich) as its type species. Inasmuch as *M. clausa* is a well-known and very typical species of *Meekopora*, no change in generic concept is required.

NEMATOPORA ULRICH, 1888

This genus was first proposed by Ulrich in 1888 (231, 234) although it was recorded as new in 1890 (Ulrich, 1890a: 401) with *N. quadrata* Ulrich (1890a: 644–645) designated as type. Miller (1889: 313) followed Ulrich (in press), giving a generic diagnosis with *N. quadrata* as type of the genus and listing three other species, all being *nomina nuda* in 1889. Neither Miller in 1889 nor Ulrich in 1890 makes any reference to the publication in which Ulrich (1888: 231, 232, 234) first proposed the generic name, gave the characters distinguishing the genus from others included in the family Arthrostylidae, and definitely assigned to *Nematopora* two previously described species, *Helopora lineata* Billings (1866: 36–37) and *Trematopora minuta* Hall = *Trematopora?* (*Trachypora?*) *minuta* Hall (1876: pl. 11, fig. 8). Although Ulrich (1888: 231) stated, "This genus together with a number of species will be described in vol. viii, Illinois geological survey, now in press," he obviously published the name in 1888 with sufficient information to distinguish the genus from related forms. As Ulrich's intended type was not named or differentiated from other species in 1888, one of the two valid species originally assigned to the genus must be chosen genolectotype. Therefore *Nematopora minuta* (Hall) is here selected type of the genus, supplanting *N. quadrata* Ulrich, which was later (Ulrich, 1893: 204–205) held to be identical with *N. ovalis* Ulrich (1890: 197), the description of which had been published a few months earlier.

As far as is known, *Nematopora minuta* (Hall) is congeneric with *N. ovalis* = *N. quadrata* Ulrich, and the designation of Hall's species as type of the genus probably will not require any revision of the present generic diagnosis.

PTYLOPORA MCCOY, 1844

The genotype, *Ptylopora pluma* McCoy (1844: 200), is apparently cited correctly by Nickles and Bassler (1900: 382) and Bassler (1935: 179), though this fact could not be ascertained from a review of the references listed in these synonymies. McCoy described two species at the time he defined the genus but failed to designate a genotype. An investigation of the articles cited in Nickles and Bassler revealed that the monograph by Hall and Simpson (1887: xxiv) was the first reference that named a genotype—*Retepora flustriformis* Phillips, one of the two available species. Miller cited the same species in 1889 (319), and Ulrich (1890a: 398) gave "(?) Type: *Retepora flustriformis* Phillips." The question therefore arose as to why *Ptylopora pluma* was cited as type of the genus in later publications, and the literature published prior to 1887 was searched in order to find an explanation for the discrepancy.

As the two standard synonymies do not list the publication in which *P. pluma* was first named the type of the genus, students should add this essential reference. Vine in 1884 (189, 191) cited *P. pluma* McCoy, the other of the two available species, as the "accepted type" and "type" of "*Ptilopora*." So far as the writer has been able to find, Vine's paper of 1884 was the first to definitely name a type species for *Ptylopora*, and this article antedates by several years the American publications noted above in which *P. flustriformis* was cited as type. This circumstance is fortunate inasmuch as Shrubsole (1879: 278–279; 1881: 181), after a careful review of the species of British Carboniferous Fenestellidae, concluded that *Fenestella flustriformis* = *Retepora flustriformis* Phillips (1836: 198–199) was based on the "cast only of the reverse face" of *Fenestella plebeia* McCoy (1844: 203). If *Retepora flustriformis* Phillips had been a valid selection, *Ptylopora* would have to be referred to the synonymy of *Fenestella* Lonsdale (1839: 677–678), a preoccupied name for which suspension of the Rules has been requested (Science, n. s., **106** (2763): 585).

STREBLOTRYPA VINE EX ULRICH, 1885

Vine (1885: 391) first published the name *Streblotrypa* in connection with Ulrich's manuscript species *S.* "*nicklisi*," specimens of which had been sent to him by J. M. Nickles. Vine also identified a fragment from the Carboniferous of Yorkshire with Nickles's material from the Chester group of Kaskaskia, Ill. Although Vine did not give a generic diagnosis, he did compare and figure the British and American specimens and described some of the characters, thereby validating the name. Bibliographies and synonymies (Nickles and Bassler, 1900: 420; Bassler, 1935: 210) credit the name *Streblotrypa* to Ulrich, 1890. There can be no doubt, however, that Vine was responsible for the original publication in 1885, and in an article published the following year (Vine, 1886: 96–97) he noted additional occurrences of *S. nicklesi* [erroneously spelled "*nicklisi*"], described a new species of the genus, and made some comments intended to justify his publication of Ulrich's manuscript name for which he had been criticized. Ulrich himself in 1888 (Ulrich, 1888a: 84–89) published descriptions of eight species of *Streblotrypa*, but not of *S. nicklesi*. If Vine had not previously published a description of the species that Ulrich intended should be the type of the genus, one of Ulrich's species of 1888 or *Ceriopora? hamiltonensis* Nicholson (1874: 161), which was referred to *Streblotrypa* in the same publication, would be the genosyntypes. A diagnosis of the genus was published by Miller (1889: 325), who took his data from Ulrich's 1890 monograph, then in press.

Fortunately Vine's concept of the genus and species was based mainly on material furnished to him by Nickles from the Chester group of Kaskaskia, Ill. Vine had only one fragment from Yorkshire, and this was subsequently reported lost (Vine, 1890: 191). In order to stabilize the nomenclature of *Streblotrypa nicklesi* Vine ex Ulrich, 1885, and exclude from further consideration the "lost" specimen from Yorkshire, which probably was not identical with the American specimens, this occasion is taken to designate the American specimens as types of the species. The present location of Vine's type specimens is unknown, but the suite of topotypes that Nickles submitted to Ulrich is catalogued under U.S.N.M. no. 43311 (Merrill, 1905: 630).

TAENIODICTYA ULRICH, 1888

Ulrich first published this name in connection with his description of *Taeniodictya interpolata* Ulrich (1888a: 80) from the Cuyahoga "shales" of Ohio. The generic name therefore dates from 1888 and not from 1889, when the generic diagnosis was first published by Miller (1889: 327), or 1890, when Ulrich's monograph was published (Ulrich, 1890a: 393). As only one species was described when Ulrich originally published the name, the genus is monotypical, with *T. interpolata* taken as the type under Article 30-Ic. When Miller published the first diagnosis in 1889, he followed Ulrich in designating *T. ramulosa* Ulrich (1890a: 528–529) as type of the genus and listed four other species and one variety. All the specific names except that of *T. interpolata* were *nomina nuda*, so the genus was still monotypical at that date.

In some respects *Taeniodictya interpolata* differs from what Ulrich called "typical species" of the genus (Ulrich, 1888a: 80). Future investigators therefore may find it necessary to revise the generic concept.

TREMATELLA HALL, 1886

The genotype commonly cited for *Trematella*, i.e., *Trematopora? annulata* Hall (1883: 147), is not admissible under Article 30 as interpreted in Opinion 7. Hall (1886: expl. pl. 25, figs. 4, 5) used the expression "nov. sub. gen. et sp." in connection with the species *Trematella glomerata*.

As neither of the two other species—*Trematopora arborea* Hall (1883: 147) and *Trematopora? annulata*—referred to *Trematella* in this publication were specifically named type of the genus, *Trematella glomerata* is to be recognized as the type by original designation. The selection of *Trematella annulata* by Hall and Simpson (1887: xiv) is consequently inacceptable.

WORTHENOPORA ULRICH IN MILLER, 1889

Owing to Miller's publication (1889: 330) of Ulrich's diagnosis with mention of the two species Ulrich intended to include in the genus, *Flustra spatulata* Prout (1859: 446) will have to be recognized as genotype. The other species, *Worthenopora spinosa* Ulrich (1890a: 669–670), which was cited as type, was undescribed and therefore unavailable.

So far as is known, recognition of *Worthenopora spatulata* (Prout) as type of the genus will not result in any change in morphologic concept.

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ORNITHOLOGY.—*Geographical variation in the American redstart* (Setophaga ruticilla).[1] Alexander Wetmore, Smithsonian Institution.

Division of the common and widely ranging American redstart, *Setophaga ruticilla* (Linnaeus), was first proposed by Oberholser,[2] who separated the birds of northwestern Canada, stating that "this western race differs from the eastern form in smaller size, smaller orange or yellow wing-spot; in the female also in paler, more grayish, less conspicuously olivaceous, upper surface." After a careful study of material available in the National Museum in 1939, the writer, however, came to the conclusion[3] that the suggested characters did not hold, and so regarded the species as indivisible. Recently Burleigh and Peters,[4] after examination of specimens from Newfoundland, conclude that there is a northern race extending across Canada that is different from the birds of southern range.

Though the collection of redstarts in the National Museum in 1939 when I first examined this problem was extensive, most of the breeding specimens from the south had been collected in the month of May. It is well known now that with species like the present one, with a considerable population that nests in the forests of northern Canada, spring migration of the northern group may be delayed later than was formerly understood, so that during May many individuals are still enroute to their northern breeding grounds. As a few casual examples relating to the species here under discussion, I have record of personal observation of redstarts near Nazaret, on the Guajira Peninsula, northeastern Colombia, on April 30, 1941, and of specimens taken at Escorial, Mérida, Venezuela, April 30, 1903, near Port-au-Prince, Haiti, May 9 and 10, 1866, in Petén, northern Guatemala, May 3, 1923, and on Amelia Island, Florida, May 10, 1905. There are so many of these reports that they can not refer to casual individuals that for some reason would not migrate, but rather it is apparent that they are birds that would nest in the far north where their nesting grounds are not open to them because of cold until the end of May. They are therefore in passage through the United States when their southern representatives are on their nesting grounds. Collections made in the month of May thus may contain a mixture of northern and southern individuals. This has led to confusion in attempts to separate a northern form.

To examine the matter of geographic variation I have selected from our large series the adult birds collected in June and July, when all were certainly on their breeding grounds. Much material taken in these two months has been added in recent years, especially from collections made by Burleigh in Mississippi and Georgia, and by Burleigh and Peters in Newfoundland, Nova Scotia, and New Brunswick, with numerous others from other sources. First comparisons were made entirely with this series, which included 69 adult males, 50 adult females, and 27 breeding males still in immature dress, covering the area from Louisiana and Georgia to Mackenzie and Newfoundland. These findings were checked subsequently with the considerable series of redstarts in the American Museum of Natural History, which I have examined through the courtesy of the Department of Birds of that institution.

It may be said at once that adult males from the far north and the far south, and from eastern and western localities, may not be distinguished with certainty on any character, or combination of characters. My first opinion, made in 1939, on a much smaller series of males thus still holds. Size, within the usual limits of individual variation, is identical in the various areas. This is easily illustrated by the following figures on wing length taken from birds (all males) collected in June and early in July, when they were on their breeding grounds:

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[1] Received February 16, 1949.

[2] Louisiana Dept. Cons. Bull. **28:** 572–573. 1938.

[3] Proc. U. S. Nat. Mus. **88:** 561–562. 1940.

[4] Proc. Biol. Soc. Washington **61:** 121. 1948.

		Mm.
14	from Alberta and Mackenzie	61.5–65.6
11	from Newfoundland	64.6–67.9
7	from Nova Scotia and New Brunswick	63.0–66.3
5	from Montana, Washington, and British Columbia	62.9–64.4
18	from Maryland, Pennsylvania, and Kentucky	62.2–67.3
8	from Georgia and Mississippi	62.3–66.5

The other usual measurements of length of tail, culmen from base, and tarsus show equal agreement.

The other principal difference that has been proposed to separate adult males is that of the size of the orange-colored spot on the wing. This is formed by orange markings that extend on the outer webs of part of the remiges from the base for an area of varying length toward the tip. This marking is always present on the secondaries but varies in extent on the primaries. In some it is found on all the primaries, while in others it is absent on these feathers except for a very faint indication at the extreme base. The basal section is concealed by the overlying coverts, the apparent extent of this coverage on the secondaries in museum skins depending in some specimens on disarrangement of the feathers, where the preparator has stripped the quills of the secondaries loose from their proper attachment on the ulna (a pernicious and unnecessary procedure that may lead to uncertainty or error in study of the relation of relative length of the feathers or of their markings). The size of the spot may be judged best by examining its extension across the primaries, and by the distance from its posterior margin to the distal tips of the longest primaries. The series at hand shows birds with small wing spots and large wing spots throughout the entire range of the species. There seems to be a tendency for more birds to have a reduced wing spot in the north, but this is not fixed, as birds with large spots and small wing spots are found indiscriminately from Mississippi and Georgia to northern Canada. Adult males, therefore, may not be separated geographically on any trenchant characters.

On examination of the excellent series of females now available it is found that those from the north are slightly darker gray above, while those from the south are faintly lighter gray and slightly more greenish. This distinction is evident also in males in immature dress that resemble the female, though in these the size of the wing spot is variable as in adults. The darker color of northern birds is slightly emphasized in immature males and females in fresh fall plumage. In this stage the northern specimens, while greenish on the back, are less so than birds from the southern sections.

Müller's description of *Motacilla tricolora*, which reads "oben ist sie schwarz, unten weiss, in den Seiten und an der Wurzel der Ruderfedern gelb, auch haben die Flügel fünf gelbe Flecken," refers to an adult male bird and thus might be either of the two subspecies here under discussion. Oberholser, however, as first reviser, has allocated the name to the northern race, an action that must be recognized under our rules of nomenclature.

In the two forms here recognized the northern one nests in general through the northern part of the Canadian Zone, and the southern one through the Transition and Austroriparian Life Zones, extending north into part of the southern area of the Canadian Zone. The two will stand as follows:

Setophaga ruticilla ruticilla (Linnaeus): Southern Redstart

Motacilla Ruticilla Linnaeus, Syst. Nat., ed. 10, **1:** 186. 1758. (Virginia.)

Females and immature males somewhat lighter gray above, washed with somewhat brighter green on the back; adult males not separable.

Breeds from Minnesota, Wisconsin, Michigan, southern Ontario (Hamilton), New York, Vermont (Newfane), New Hampshire (Hollis), and southern Maine (Big Lake in Washington County, Andover, Auburn, Eliot) south to southeastern Louisiana, central Mississippi, central Alabama, and central Georgia.

Recorded in migration and winter to southern Texas (San Antonio, Pecos City, Lomita, Brownsville), the Gulf coast of Louisiana, Mississippi, and Alabama, Florida, British Honduras (El Cayo), Guatemala (Panajachel, Chimoxan, Finca Chama, Alto Vera Paz), Costa Rica (Angostura, Naranjo), Panamá (Boquerón, Boquete in Chiriquí, San José Island, and Mount Tacarcuna, Darién), Bahama Islands (New Providence), Cuba (Mariel, Guamá, Monte Verde), Jamaica (Trelawney, St. Andrews, Falmouth, Spanish Town), Haiti (Gonave Island, Port-au-Prince, Petites Cayemites), Dominican Republic (Azua, Sánchez), Puerto Rico (Mayagüez, Anegado Lagoon, Río Piedras, Mameyes), Culebra Island, St. Thomas, St. John, Saba, St. Vincent, St. Lucia, Antigua, Sombrero, Barbuda, Montserrat, Guadeloupe, Dominica, Trinidad, Colombia (many records), throughout Ecuador (Ibarra, Zamora, Mindo, Esmeraldas, Papallacta), and Venezuela (south to Roraima and Auyan-tepui); casual in Baja California (Miraflores).

Setophaga ruticilla tricolora (Müller): Northern Redstart

Motacilla tricolora Müller, Vollst. Natur.-Syst. Suppl. Reg. Band: 175. 1776. ("Cayenne.")

Females and immature males somewhat darker above, washed with duller green in immature dress; adult males not separable.

Breeds from Yukon, Mackenzie (mouth of Nahanni River, Fort Simpson), and northern Alberta (Athabaska Delta, Fort Chipewyan, Slave River, Moose Factory) south through British Columbia (east of the Coast and Cascade Ranges) to west-central Washington (Winthrop), Idaho, northern Utah, and Montana (Terry, Darnalls, Fort Keogh), eastward through Alberta, Saskatchewan, central Ontario, and Quebec to Newfoundland, northern Maine, New Brunswick, and Nova Scotia (North Sydney, Wolfville).

Recorded in migration and winter in Oregon (McEwen, Ironside), Wyoming (Fort Steele, Douglas), North Dakota (Cannonball, Goodall, Dawson), Nebraska (Valentine), Arizona (Paradise, San Bernardino Ranch), Minnesota (Fort Snelling), Michigan (St. James, Ann Arbor), Illinois (Mount Carmel), Indiana (Wheatland), Arkansas (Winslow), Tennessee (Hornbeak, Crossville), New York (Montauk Light, Shelter Island, Jamaica, Parkville, Cold Spring), New Jersey (Franklin, West Orange, Morristown), Maryland (Chesapeake Beach, Laurel, Kensington), District of Columbia, Virginia (Four Mile Run, Ballston, Falls Church, Campbell County), North Carolina (Reidsville, Pisgah National Forest, Mount Mitchell), Georgia (Stone Mountain Athens, Decatur, Lawrenceville), Texas, (San Antonio, Point Bolivar, Point Isabel, Brownsville), Louisiana (Baton Rouge, Woolmarket, New Orleans), Mississippi (Gulfport, Deer Island, Ship Island), Alabama (Teasley's Mill), Florida (Amelia Island, Gainesville, Dry Tortugas), Veracruz (Tres Zapotes), Yucatán, (Gaumer specimen, probably from Mérida), Puebla (Metlaltoyuca), Tabasco (Teapa); British Honduras (El Cayo, Belize); Guatemala (La Libertad, Petén, Livingston, Progreso, Finca Chama, Secanquim); Honduras (San Pedro Sula), Costa Rica (Volcán Turrialba, Angostura); Panamá (Boqueté); Bahama Islands (Green Cay); Cuba (Mariel, Guamá, Doce Leguas, Puerto Gibara); Swan Island; Jamaica (Salt Ponds, Falmouth); Haiti (St. Michel, Cerca-La-Source, Morne La Hotte, Gonave Island, Île à Vache); Dominican Republic (Moca, Espaillet, Los Cabuyos, Constanza, Ciudad Trujillo, Sánchez); Puerto Rico (Mayagüez, Caguas, Fajardo); St. Thomas; Tortola; Antigua; Dominica; Guadeloupe; Colombia (Bonda, Las Nubes, Onaca, Valparaiso, Cali, Virolín, Maicao); Ecuador (Papallacta); Venezuela (Escorial, Nevado, El Valle, Colonia Továr, Mount Guacharo, Caicara, Mount Auyan-tepui, Cerro Yapacana); Brazil (Serra Imeri, near Salto do Hua).

The two forms apparently migrate and winter together. In the United States in migration they cover the region east of the Rocky Mountains, with occasional stragglers at more western localities. The flight extends through both Central America and the West Indies to northern South America, where the birds are most common in hilly and mountainous areas. While the two range together the northern race is evidently less numerous in individuals, a fact explained by the much smaller breeding area that it occupies.

The specimen reported from Serra Imeri, Brazil, taken December 7, 1930, by E. G. Holt, while on an expedition for the National Geographic Society is one of three records of the redstart from that country. The others are based on a bird taken January 24, 1939, on the upper Rio Cotinga, and on one from the mountain range called Serra Tapirapec or Curupira in April 1946. These two, recorded by Phelps and Phelps,[5] have not yet been identified to subspecies.

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[5] Bol. Soc. Ven. Cienc. Nat. **11**: 71. 1947.

ICHTHYOLOGY.—*A new species of goby and new records of fishes from the Solomon Islands.*[1]

ROBERT R. HARRY, Natural History Museum, Stanford University. (Communicated by Herbert Friedmann.)

During a period from the early summer of 1944 to the late spring of 1945 Robert C. Pendleton, of Weber College, Ogden, Utah, accumulated a small collection of fishes from the Solomon Islands. At least 40 species were taken southeast of "The Slot" (New Georgia Sound) below Indispensable Strait from the Aggella Group (sometimes Ngella) at Russell (Pavuvu), Gavutu, Tulagi, Florida, and Guadalcanal (Guadalcanar) Islands. Many of the species are new records for the Solomon Islands, and almost all are at least new distributional records within the Solomons. Apparently the few specimens collected from Renard Sound, Banika Island, represent the first fish collection ever recorded from the Russell Group.

Pendleton's collections were taken at seven definite localities: (1) Renard Sound, Banika Island, Russell Group, latitude 9°5′S., longitude 159°13′E. (U. S. Hydrographic Office Chart 5980). (2) Brackish creek near Lengo, approximately 2 miles east of the mouth of the Tenaru River, on the north coast of Guadalcanal Island, latitude 9°25′S., longitude 160°8′30″E. (H. O. Chart 2896). (3) Sea level on mud flats at mouth of Tenaru River near the village of Tenaru, Guadalcanal Island, latitude 9°30′S., longitude 160°6′E. (H. O. Chart 2896). (4) Little Tenaru River, southeast tributary of the Tenaru River, latitude 9°30′S., longitude 160°6′E. (H. O. Chart 2896). (5) Tulagi Harbor between Tulagi Island and Makambo Island, Florida Group, latitude 9°5′S., longitude 160°9′E. (H. O. Chart 2916). (6) Gavutu Bay between Gavutu Island and Hutchison Point, Florida Islands, latitude 9°6′S., longitude 160°11′E. (H. O. Chart 2916). (7) Purvis Bay, mouth of Hutchison Channel, north of Port Purvis, Florida Island, latitude 9°6′20″S., longitude 160°13′30″E. (H. O. Chart 3012).

A new species of goby, or sleeper, is described from material taken in a small creek on Guadalcanal and represents the second known species of *Fagasa*, a genus previously known only from a single specimen from Tutuila Island, Samoa Islands. In addition to the material reported upon, an apparently very distinct undescribed species of *Doryichthys* collected entering a creek near the ocean 1 mile west of Tenaru River, Guadalcanal Island, May 20, 1944, is not included here. This single specimen obtained has been forwarded to Dr. Earl S. Herald, of the California Academy of Sciences, to be included in his investigations of the family Syngnathidae.

The literature on the fishes of the Solomon Islands is extremely scattered and incomplete. Until very recently[2] no actually intensive collections had been undertaken there; although various British, Australian, and American collectors have obtained many specimens during short stays in the Archipelago. The fish fauna of the Solomons was almost completely unknown previous to Dr. Albert Günther's important contribution (1873) in the fish section of Brenchley's *Cruise of the* Curaçoa *among the South Sea Islands.* Günther compiled a list of 68 species of fishes, including two new species, from three separate Solomons collections received nearly at the same time by the British Museum. No data as to locality within the Solomon Islands were given. Alvin Seale (1906) made extensive collections in the South Pacific for the Bishop Museum about 1903 and obtained a large collection of fishes from Shortland Island in the northern part of the Solomons. Six species were described as new. The most important recent review is the very useful checklist of the fishes of the Solomon Islands by Herre (1931). Many of the specimens upon which Herre based his checklist are at Stanford University and have been compared with the present material.

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[1] Received December 3, 1948.

[2] Dr. Wilbert McLeod Chapman, while with the Foreign Economic Administration of the United States Government, amassed excellent large collections of the shore and pelagic fishes of the Solomon Islands. At present this material is partly at the School of Fisheries, University of Washington, and partly at the United States National Museum.

Subsequent to Herre, the Templeton Crocker Expedition to western Polynesian and Melanesian Islands, 1933, returned with excellent collections from throughout the Solomons. Seale (1935) reported upon this material, which is presently in the fish collection of the California Academy of Sciences.

The Pendleton collection, including the types, has been deposited in the Natural History Museum of Stanford University, and the number before each locality represents the Stanford catalog number. A set of duplicate specimens has been retained by the collector.

I wish to thank Mr. Pendleton for allowing me to prepare this report upon his interesting collections of fishes and for considerable help throughout. He prepared extensive ecological notes of several of the species and intends to have these observations published.

SYNODIDAE

(1) **Saurida undosquamis** (Richardson)

No. 14761, Purvis Bay, Florida Island, January 22, 1945, 1 specimen.

The range of this species is from East Africa through the Indian Ocean to Australia and Japan. Exact records of its distribution are somewhat confused, because this form has been confounded with the so-called *Saurida tumbil* (Bloch). Apparently it has not been recorded in the Solomons. The nearest previous record is in the Louisiade Archipelago.

ANGUILLIDAE

(2) **Anguilla bicolor** McClelland

No. 14758, Brackish creek near Lengo, Guadalcanal Island, May 20, 1944, 1 specimen.

This species is known throughout the East Indian Archipelago. Its range is here extended eastward from New Britain and numerous localities in northern New Guinea.

MURAENIDAE

(3) **Muraena undulata** (Lacepède)

No. 14760, Purvis Bay, Florida Island, December 23, 1944, 1 specimen.

This species is distributed from the east coast of Africa through the Indian Ocean eastward to Australia and as far as the Hawaiian Islands. Seale (1935, p. 343) records it from the Solomons at Sikaiana Island, Stewart Islands.

(4) **Echidna nebulosa** (Ahl)

No. 14759, Purvis Bay, Florida Island, December 23, 1944, 1 specimen.

East coast of Africa to Australia, Pacific islands. Recorded from Tulagi Island, Florida Islands by Seale (1935, p. 343).

SYNGNATHIDAE

(5) **Hippocampus kuda** Bleeker

No. 14762, Purvis Bay, Florida Island, January 23, 1945, 1 specimen.

Distribution from East Africa through the Indo-Australian Archipelago and to Japan. The species has not been recorded before from the Solomon Islands but has been taken from nearby British South New Guinea.

SERRANIDAE

(6) **Epinephelus cyanostigma** (Cuvier and Valenciennes)

No. 14767, Purvis Bay, Florida Island, December 22, 1944, 1 specimen; No. 14768, same locality, April 1, 1945, 1 specimen; No. 14769, same locality, January 21, 1945, and March 29, 1945, 1 specimen.

Range: Indo-Australian Archipelago. Not previously recorded from Solomon Islands.

(7) **Epinephelus urodelus** (Cuvier and Valenciennes)

No. 14772, Purvis Bay, Florida Island, no date, 1 specimen.

Known from Madagascar through Indian Ocean, Indo-Australian Archipelago eastward to Society Islands. Not previously recorded from the Solomon Islands.

(8) **Epinephelus pachycentron** (Cuvier and Valenciennes)

No. 14771, Purvis Bay, Florida Island, December 16, 1944, 1 specimen.

Previously recorded in the Solomons from Tulagi Island, Florida Group by Seale (1935, p. 359).

(9) **Epinephelus diacanthus** (Cuvier and Valenciennes)

No. 14770, Purvis Bay, Florida Island, December 20, 1944, 1 specimen.

Distributed from East Africa through Indian Ocean to eastern Pacific. Apparently this record represents a range extension eastward from the Philippines.

PSEUDOCHROMIDAE

(10) **Pseudochromis fuscus** Müller and Troschel

No. 14799, Purvis Bay, Florida Island, December 23, 1944, 4 specimens; No. 14800, same locality, January 21 and March 29, 1945, 2 specimens.

Recorded by Herre (1931, p. 6) from Shortland Island, Solomons.

CARANGIDAE

(11) **Caranx crumenophthalmus** Bloch

No. 14765, Purvis Bay, Florida Island, January 20, 1945, 1 specimen.

Apparently this is the first definite locality record within the Solomon Archipelago.

(12) **Caranx chrysophrys** Cuvier and Valenciennes

No. 14764, Purvis Bay, Florida Island, February 5, 1945, 1 specimen.

Distribution from east Africa through Indian Ocean to Australia. Apparently closest record to Solomons is Queensland.

(13) **Decapterus macrosoma** Bleeker

No. 14766, Renard Sound, Banika Island, Russell Group, March 15, 1945, 1 specimen.

Range: East Africa to Australia. Not previously mentioned from Solomon Archipelago.

LUTIANIDAE

(14) **Lutianus vitta** (Quoy and Gaimard)

No. 14775, Purvis Bay, Florida Island, March 25, 1945, 1 specimen.

Range: Seychelles Islands through Indian Ocean to Australia. Previously not known from Solomons. Closest records New Guinea and Louisiade Archipelago.

(15) **Lutianus sebae** (Cuvier and Valenciennes)

No. 14774, Purvis Bay, Florida Island, March 29, 1945, 1 specimen.

East coast of Africa through Indian Ocean, Indo-Australian Archipelago to Australia. Not recorded from Solomons.

(16) **Pentapodus setosus** Cuvier and Valenciennes

No. 14776, Purvis Bay, Florida Island, March 22, 1945, 1 specimen.

Range: Indo-Australian Archipelago. Previously unrecorded in Solomons.

(17) **Monotaxis grandoculis** (Forskål)

No. 14777, Purvis Bay, Florida Island, May 18, 1945, 1 specimen.

Herre (1931, p. 7) established this species in the Solomons from Tenibuli, Ysabel Island; Hathorn Sound, New Georgia Island; Shortland Island; Sikaiana Island; Stewart Island.

MULLIDAE

(18) **Upeneus vittatus** (Forskål)

No. 14763, Purvis Bay, Florida Island, May 18, 1945, 1 specimen.

Very common in Indo-Australian Archipelago. Apparently never reported from the Solomon Islands.

KYPHOSIDAE

(19) **Kyphosus cinerascens** (Forskål)

No. 14778, Gavutu Island, Florida Group May 18, 1945, 1 specimen.

Mentioned by Herre (1931, p. 7) from Solomons at Tenibuli, Ysabel Island; and Shortland Island.

CHAETODONTIDAE

(20) **Chaetodon octofasciatus** Bloch

No. 14787, Purvis Bay, Florida Island, January 21, 1945 and March 29, 1945, 1 specimen.

Ranges through Indo-Australian Archipelago. Recorded by Herre (1931, p. 7) from Solomons at Tenibuli, Ysabel Island, and Bougainville Island. Weber and de Beaufort (1936, p. 75) establish it from New Pommern, Solomons.

POMACENTRIDAE

(21) **Pomacentrus tripunctatus** Cuvier and Valenciennes

No. 14782, Purvis Bay, Florida Island, December 23, 1944, 1 specimen; No. 14783, Purvis Bay, Florida Island, January 21, 1945, and March 29, 1945, 2 specimens.

Recorded from the Solomons by Herre (1931, p. 8) from Auki, Malaita Island; Hathorn Sound, New Georgia Island; Tenibuli, Ysabel Island.

(22) **Pomacentrus bifasciatus** Bleeker

No. 14781, Purvis Bay, Florida Island, December 23, 1944, 3 specimens.

Range: Indian Ocean and Archipelago. Previously unrecorded from Solomons. Closest published accounts at Palau (Pelew) Islands, Boston Island (Ebon Atoll) and Duke of York Island.

(23) **Dascyllus aruanus** Linnaeus

No. 14779, Purvis Bay, Florida Island, January 21, 1945, and March 29, 1945, 4 specimens.

Previously recorded by Herre (1931, p. 8) from the Solomons at Shortland Island; Kungava Bay, Rennell Island; Sikaiana Island, Stewart Islands.

(24) **Dascyllus melanurus** Bleeker

No. 14780, Purvis Bay, Florida Island, January 21, 1945, and March 29, 1945, 1 specimen.

Previously recorded from the Solomons by Herre (1931, p. 8) at Shortland Island and by Seale (1935, p. 368) at Kungava Bay, Rennell Island; Sikaiana Island, Stewart Islands.

(25) **Premnas biaculeatus** (Bloch)

No. 14784, Purvis Bay, Florida Island, January 21, 1945, and March 29, 1945, 1 specimen.

Previously recorded from Kungava Bay, Rennell Island, Solomons by Seale (1935, p. 365).

Labridae

(26) **Cheilinus fasciatus** (Bloch)

No. 14785, Purvis Bay, Florida Island, December 28, 1944, 1 specimen.

Previously reported from the Solomons by Herre (1931, p. 8) at Tenibuli, Ysabel Island; Shortland Island.

(27) **Thalassoma lunare** (Linnaeus)

No. 14786, Purvis Bay, Florida Island, January 16, 1945, 1 specimen.

Previously recorded from the Solomons by Herre (1931, p. 8) at Hathorn Sound, New Georgia Island, and Shortland Island.

Teuthididae

(28) **Zebrasoma flavescens** (Bennett)

No. 14788, Renard Sound, Banika Island, Russell Group, April 14, 1945, 1 specimen.

Previously recorded from Hathorn Sound, New Georgia Island, Solomons, by Herre (1931, p. 7).

Eleotridae

(29) **Eleotris melanosoma** Bleeker

No. 14795, Little Tenaru River, Guadalcanal Island, May 14, 1944 (fresh water), 1 specimen.

Reported by Herre (1931, p. 9) from Auki, Malaita Island, Solomons, in fresh water.

(30) **Fagasa diaphana**, n. sp.

This species is very closely related to *Fagasa tutuilae* Schultz (1943, p. 253) and represents the second known species of this remarkable genus. Schultz described *F. tutuilae* from a single young specimen 18.5 mm in standard length. Though he distinguished this genus from all other groups of the family Eleotridae, he made no mention of its relationships and position in the family. One of the most striking characteristics of *F. tutuilae* is its emarginate caudal (shown as lunate in the figure), which apparently is present in only one other eleotrid genus, *Ptereleotris*. All other eleotrids have rounded or elongated caudals. *Ptereleotris*, however, has much higher counts for soft dorsal rays (24–32 versus 6–8), anal soft rays (22–27 versus 8), and longitudinal scale series (150–170 versus 19–31). It is expected that future collections near the mouths of shallow coastal streams in the Pacific oceanic islands will reveal additional representatives of this group.

Holotype.—Stanford University No. 14894; 17.3 mm in standard length; mouth of small brackish stream near Lengo, north coast of Guadalcanal Island, May 20, 1944.

Paratypes.—Stanford University no. 14895; 6.8–18.3 mm in standard length; same data as holotype; 70 specimens. Stanford University number 14896; 15.8–18.4 mm in standard length; entering creek, one mile west of Tenaru River (from salt water), Guadalcanal Island, May 20, 1944; 3 specimens.

Diagnosis.—This species is referable to the genus *Fagasa* on the basis of the following characters: Mouth nearly vertical; no teeth on vomer; gill membranes continued moderately far forward and joined to the isthmus without a free fold across it; body anteriorly naked; the scales ctenoid, beginning under the second dorsal; dorsal fin rays VI, I, 8; anal fin I, 8; pectoral fin 17 or 18; pelvic fins completely separate without connecting basal membrane; all fin rays simple, unbranched; caudal fin emarginate or lunate.

This species can be readily differentiated from the only other known species, *F. tutuilae*. The lower jaw in *diaphana* is prominent, definitely entering into the dorsal profile, while in *tutuilae* the lower jaw is not so well developed and does not enter the dorsal profile. Scales 19–21 in a midlateral series to caudal base in the latter, 31 in the former. The scales in the new species are confined to an oval patch on the sides of the body 6 or 7 scales in height; no scales extend onto the caudal fin. The figure of *tutuilae* shows the scales apparently continuous on each side of the body dorsally behind the dorsal fin and ventrally behind the anal fin; there appear to be at least 10 oblique scale rows; in addition the base of the caudal fin is illustrated as scaled. None of these scale characters are discussed by Schultz, however. The pelvic fins in *diaphana* extend only slightly beyond a vertical from the origin of the first dorsal fin, but in the figure of *tutuilae* the pelvics extend beyond the first dorsal fin base.

Description.—Measurements were made with fine-pointed dividers and divided into either head or standard length as indicated. Considering the very small size of the types, there is an unavoidably significant margin of error in measurement, and only the measurements for the holotype are presented. More importance has been placed in the description of species characteristics. Counts were taken from 25 specimens. The results for the paratypes are placed in parentheses and are preceded by those for the holotype.

Body elongate, moderately compressed, greatest depth between tips of pelvic fins and anus, 6.4 in standard length.

Head elongate, somewhat depressed, its length 3.6 in standard length. Profile almost straight between snout and interorbital; slightly raised before vertical from eye. Snout length 4.5 in head. Anterior nostril at border of labial fold, on a level with middle of eye. Posterior nostril at upper anterior border of eye. Both nostrils lack raised borders except anterior margin of posterior nostril with a slightly raised flap. Orbit large, posterior margin nearer to snout tip than opercular margin, diameter 5.0 in head length. Interorbital much narrower than eye diameter, 8.3 in head. Jaws strongly oblique, the lower jaw prominent, definitely entering into the dorsal profile. Maxillary extends distinctly lower than eye in horizontal level, but does not reach a vertical from anterior margin of eye. Length of upper jaw 3.3 in head. Jaws with a single row of moderate canines laterally, two or three closely spaced rows anteriorly. No teeth evident on vomer or palatines.

The pattern of head papillae distinctly the same as that characteristic of the subfamily Eleotrinae (see Harry, 1948, pp. 14–15, figs. 1, 2). No pores are present except one, usually denoted in the literature as pore a, that is situated at the upper posterior border of the eye. No papillary grooves are present. Generally five single papillae lines radiate from the ventral border of eye. Papillae lines on sides of head prominent, in single series. Interorbital naked, lacking papillae, except for three short parallel rows radiating inward from eye (genipore rows *t*, *v*, and *w*); *b* and *d* series on cheek well developed; *c* series very short, confined to above end of maxillary; *a* series irregular, interrupted and indistinct; *os*, *ot*, and *or* series on operculum well developed and elongate. A single continuous row of papillae designated by Ilgin and de Buen as *n* extends completely across the nape.

Scales ctenoid with large ctenii, confined to posterior half of body in an oval-shaped area on each side. Scales begin above origin to end of anal base and extend almost to base of caudal fin. Nineteen to 21 scales from where they begin along midaxis of body to base of caudal fin. Six or seven vertical oblique series of scales.

First dorsal fin rounded, with six rays. Outline not as in figure of *tutuilae*. First rays graduated, third ray longest. Last spinous dorsal ray very short, bound to back. Length of first dorsal base 7.3 in standard length. Origin of first dorsal over tips of pelvic rays, its distance from tip of snout 2.3 in standard length. Second dorsal outline as in figure of *tutuilae*, except penultimate and last rays shorter, the outline more abruptly rounded. Length of second dorsal base 7.9 in standard length. Origin of second dorsal slightly in advance of anal origin. Anal rays I, 8, outline of fin the same as in *tutuilae*. Length of anal base 7.9 in standard length. Distance from tip of snout to anal origin 1.7 in standard length.

Pectoral large and rounded with 17 or 18 rays, extending to a vertical from the end of the base of the first dorsal. Length of longest pectoral ray 4.8 in head length. Pelvic fins I, 5, separated to the base and without a basal membrane. Pelvic origin slightly behind pectoral origin, its rays extending slightly beyond a vertical from first dorsal origin. Outline of pelvic fins similar to that of *tutuilae*.

Caudal fin large; lunate or emarginate. No scales on base of fin. Principal caudal rays 12 or 13, none divided. Length of caudal fin 3.8 in standard length.

Measurements in percentage of standard length: Body depth 15.6; caudal peduncle least depth 12.3; length of caudal peduncle from base of last dorsal ray to midbase of caudal fin 26.5; head length 28.9; snout length 6.4; upper jaw length 8.7; orbit length 5.8; interorbital width 3.5; distance from tip of snout to spinous dorsal origin 41.6; spinous dorsal base length 13.9; longest dorsal spine length 15.3; soft dorsal base length 12.7; distance from tip of snout to anal origin 58.3; anal base length 12.7; longest anal soft ray length 14.4; pectoral fin base width 5.8; pectoral fin length 20.8; distance from tip of snout to pelvic fin origin 30.0; pelvic fin length 16.8; caudal fin length from midbase to tip of longest lateral ray 26.0.

Coloration.—Mr. Pendleton has informed me that all the specimens were "virtually transparent" when alive. In alcohol (first preserved in formaldehyde) they are an opaque flesh color with large scattered chromatophores arranged in a definite characteristic pattern. Body with a few scattered melanophores on upper sides of body, on the base of the pectoral fin and a single series along each side of the bases of the dorsal fins. A darker, more deeply imbedded interrupted pigment streak extends along the midventral line of the body from a vertical immediately behind the eye to the procurrent caudal rays. A longitudinal blotch is present on the median section of chin. The most striking color feature is a rectangular blotch of melanophores at the base of the caudal fin. Widely spaced scattered melanophores present behind eye and on top of head, somewhat concentrated on occiput.

This species is named *diaphana* from the Greek *diaphanes* = transparent in reference to the transparency of the living examples.

GOBIIDAE

(31) **Gobiodon erythrospilus** Bleeker

No. 14899, Purvis Bay, Florida Island, December 23, 1944, 1 specimen.

It has not been recorded from the Solomons in the literature.

(32) **Gobiodon quinquestrigatus** Cuvier and Valenciennes

No. 14796, Purvis Bay, Florida Island, December 23, 1944, 14 specimens; no. 14797, Purvis Bay, Florida Island, January 21, 1945, or March 29, 1945, 1 specimen.

A large number of forms, probably several distinct species are recognized under this species. The genus *Gobiodon* is in great need of revision.

Previously recorded under the name *Gobiodon rivulatas* from Kungava Bay, Rennell Island by Seale (1935, p. 372 and from Howla Island, Solomons, by Herre (1931, p. 9).

(33) **Paragobiodon echinocephalus** (Rüppell)

No. 14798, Purvis Bay, Florida Island, December 23, 1944, 21 specimens.

Previously recorded from Bougainville Island and Shortland Island, Solomons, by Herre (1935, p. 9).

PERIOPHTHALMIDAE

(34) **Periophthalmus koelroeteri** (Pallas)

No. 14897, mouth of small brackish stream near Lengo, north coast of Guadalcanal Island, May 20, 1944, 8 specimens; no. 14898, sea level on mud flats at mouth of Tenaru River, Guadalcanal Island, May 20, 1944, 2 specimens.

Previously recorded from Auki, Malaita Island and Bougainville Island, Solomons, by Herre (1931, p. 9).

BLENNIIDAE

(35) **Salarias guttatus** Cuvier and Valenciennes

No. 14801, Purvis Bay, Florida Island, January 4, 1945, 2 specimens.

Apparently not known from Solomons. Dr. W. M. Chapman made this determination for me.

TRIGLIDAE

(36) **Abalistes stellaris** (Bloch and Schneider)

No. 14789, Purvis Bay, Florida Island, December 28, 1944, 1 specimen.

Previously unrecorded from the Solomons.

(37) **Balistapus capistratus** (Tilesius)

No. 14790, Purvis Bay, Florida Island, December 23, 1944, 1 specimen; no. 14791, same locality, January 15, 1945, 1 specimen; no. 14792, same locality, March 15, 1945, 1 specimen.

Previously unrecorded from the Solomons.

(38) **Odonus niger** (Rüppell)

No. 14793, Gavutu Bay, Gavutu Island, Florida Group, May 8, 1945, 1 specimen.

Apparently the first definite locality record for the Solomons.

(39) **Tetraodon nigropunctatus** Bloch and Schneider

No. 14794, Tulagi Harbor, Tulagi Island, Florida Group, May 1, 1945, 1 specimen.

Recorded from Shortland Island, Solomons, by Herre (1931, p. 9).

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Obituaries

François Emile Matthes.—In 1947, after 51 years of distinguished service with the U. S. Geological Survey, François Emile Matthes retired to El Cerrito, Calif. There, near the mountains he loved, he planned to continue the studies to which he had devoted much of his long and fruitful life. These plans, however, were abruptly ended by his death on June 21, 1948, less than a year after his retirement.

Although born in Amsterdam, Holland, on March 16, 1874, he came with his family to America in 1891 and soon became a naturalized citizen. In 1895 he received a B.S. degree from the Massachusetts Institute of Technology and the following year joined the Topographic Branch of the Geological Survey. For almost 20 years he was engaged in the preparation of topographic maps of such spectacular and difficult areas as the Big Horn Mountains, that part of the Rocky Mountains which is now Glacier National Park, the Grand Canyon of the Colorado, Yosemite Valley, and Mount Rainier National Park. The superb artistry and deep understanding of landforms, displayed in his delineation of terrain by the contour line, were matched by his interest in the processes which produced these landforms. His early work in the Big Horn Mountains led directly to studies of glaciation and the geomorphic processes of high altitudes, reported in the first of his long series of publications, *The glacial sculpture of the Big Horn Mountains* (21st Ann. Rep. U. S. Geol. Surv., pt. 2. 1900), in which he named the process of "nivation." In 1914, Mr. Matthes transferred to the Geologic Branch of the Geological Survey in order to devote himself exclusively to studies of glaciers and the development of landforms. However, during both World Wars I and II he was called by the Army and Air Forces to be a consultant. His long record of professional achievements are typified by his classic study, *The geologic history of the Yosemite Valley* (U. S. Geol. Surv. Prof. Pap. 160. 1930).

In 1931 Mr. Matthes was made chairman of the committee on glaciers of the section of hydrology of the American Geophysical Union, charged with collecting the results of studies and measurements of existing glaciers and their fluctuations throughout the world. At the time of his death he was also secretary of the commission on snow and glaciers of the International Association of Scientific Hydrology of the International Union of Geodesy and Geophysics. His interest in glaciers and the processes of glaciation, and his recognition of the recent reestablishment of glaciers in the mountains of western United States, named by him the *Little Ice Age* (chapter on "Glaciers" in *Hydrology*, Physics of the Earth Series **9**: 1942), led directly into the disciplines of climatology and meteorology. At the time of his death he was engaged in the completion of an important critical analysis of the glacial anticyclone theory, of which only part 1 has been published, *The glacial anticyclone theory in the light of recent meteorological data from Greenland* (Trans. Amer. Geophys Union **27**: 324–341. 1946).

In recognition of Mr. Matthes' high professional attainments, he was decorated Chevalier, Order of Leopold II (Belgium) in 1920, elected president of the Geological Society of Washington in 1932, president of the American Association of Geographers in 1933, and vice-president of the Washington Academy of Sciences from the Geological Society of Washington in 1934. Shortly before his death he was presented a gold medal by the Department of the Interior for his long and distinguished service to the Government. When, in 1947, he received an honorary LL.D. degree from the University of California, President Sproule said, "By your artistry in the delineation of landforms and your clear, scientific description, you have interpreted the beauty of the western American landscape to the mind, as well as the eyes, of all who love the mountains." Through active association with such organizations as the National Park Service, the Boy Scouts of America, and the Sierra Club, and through the many popular scientific articles written for the layman, he brought his appreciation and understanding of the beauty and development of the landscape to the layman. The honor which he prized most highly was the "Order of the Silver Beaver," conferred upon him by the Council of the Boy Scouts of America for "distinguished service to boyhood."

The passing of François Emile Matthes is a great loss to his many professional and personal friends throughout the world. He leaves to us as an enduring monument, his published works in which we can find his deep understanding, appreciation, and devotion to the beauty and orderliness of the natural landscape.

Louis L. Ray.

Oscar Edward Meinzer was born on a farm near Davis, Ill., on November 28, 1876. He died in his home in Washington, D. C., on June 14, 1948. He is survived by his wife, Alice Crawford Meinzer, and two sons—Robert William, of Berwyn Heights, Md., and Roy Crawford, of New Brunswick, N. J.

Meinzer was one of six children of William and Mary Julia Meinzer. From them he acquired a strong hatred of war, deep religious convictions, an independent inquiring but orderly mind, and a capacity for hard, concentrated work. His interest in geology was aroused during his early boyhood by his observation of fossil-packed limestone beds overlain by glacial till containing erratics that were foreign to the locale of his father's farm. His interest in ground water was aroused at an early age by the difficulties experienced by his father in obtaining water for domestic and stock use. As a means to knowledge about these and many other observations that aroused his curiosity, he eagerly seized the opportunity for a college education and entered Beloit College (Wisconsin) from which he was graduated, magna cum laude, in 1901, having been elected to Phi Beta Kappa. After graduation he was principal of schools at Frankfort, S. Dak., for two years. He then taught science at Lenox College, Iowa, and in 1905 entered the graduate school at the University of Chicago, which later awarded him the degree doctor of philosophy, magna cum laude.

Having completed his residence requirements at Chicago, in 1907 he was appointed junior geologist in the U. S. Geological Survey and began his lifelong study of ground water. In 1913 he was made chief of the Ground Water Division, and he continued in that capacity until his retirement on November 30, 1946.

Meinzer made many investigations of the geology and ground-water resources of various areas in the West, in Cuba, and in the Hawaiian Islands. In later years he wrote extensively on the occurrence of ground water, its recharge, movement, and discharge. His bibliography contains about 110 items, most of which are substantial contributions to science. The most important of these probably are his *Occurrence of ground water in the United States, with a discussion of principles*, *Outline of ground-water hydrology, with definitions*, and the volume on *Hydrology* of which he served as editor and also wrote a section on the occurrence of ground water, and was co-author of a section on the movements of ground water.

Early in his career, Meinzer recognized that ground water was destined to become increasingly important as a natural resource and that adequate methods would have to be worked out for determining the location, distribution, volume, and physical characteristics of ground-water reservoirs; their storage capacities, rates of recharge, movement, and discharge and the safe rates of withdrawals of water from them. Previous work had been along two distinct lines, by the geologists and by the physicists and engineers, with little or no coordination between these groups. One of the greatest services that Meinzer performed was to bring together geologists and engineers in the development of a systematic and comprehensive science of groundwater hydrology.

Dr. Meinzer was president of the Washington Academy of Sciences in 1936; president of the Geological Society of Washington in 1930–31; a charter member of the Society of Economic Geologists and its president in 1946. He took an active part in the formation of the section of hydrology of the American Geophysical Union and was its first chairman. At the time of his death he was president of the American Geophysical Union; president of the International Commission on Subterranean Water, and American member of the executive committee of the International Association of Scientific Hydrology. He was a fellow of the Geological Society of America and of the American Association for the Advancement of Science; a member of the National Research Council; the American Water Works Association; and the Pick and Hammer Club of Washington. He was also a member of Sigma Xi and of the Cosmos Club of Washington.

Dr. Meinzer was awarded the Bowie Medal of the American Geophysical Union in 1943 for outstanding contributions to hydrology, and in 1946 was awarded the honorary degree doctor of sciences by his alma mater, Beloit College.

He was deeply interested in people, especially in boys. For many years he was an elder and taught boys' classes in the Sherwood Presbyterian Church (Washington). He participated actively in the Boy Scout movement, first as a scoutmaster and later as a member of the Capital Area Council. He was a 30-year veteran in the Scouts.

Although he retired from active duty with the Geological Survey in 1946, Meinzer continued active. Until the day of his death he was busily preparing for the Assembly of the International Union of Geodesy and Geophysics in Oslo, which he expected to attend with Mrs. Meinzer, and was engaged in writing a treatise on ground water, which remains unfinished. His death is a great loss to science, to a host of friends and admirers, and to the many colleagues who were initiated in ground-water investigations under his critical but kindly leadership.

A. NELSON SAYRE.

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ETHNOLOGY.—*A visit to Laos, French Indochina.*[1] JOHN EMBREE, Yale University.

This is a summary report of a trip made in 1948 to little-known Laos in French Indochina as an initial field survey in connection with the writer's appointment to the Southeast Asian Studies program at Yale University. The writer had just finished a period of about one year as cultural officer for the Department of State in Bangkok and Saigon and so had acquired some background context for observation in Laos, a region the culture of which is basically similar to that of Siam and the administration of which is through the French.

Arrangements were made for the trip through M. de la Fournière, head of the Bureau de la Presse et de l'Information in Saigon. Thanks are due to him and to the numerous French and Laotian officials who assisted the writer in his trip through Laos—not only with information, but with generous hospitality as well.

The places visited included North and South Laos and both towns and rural areas. The itinerary was as follows:

Saigon–Vientiane by plane.
Vientiane–Xieng Khouang–Luang Prabang–Vientiane by Piper Cub provided by the French Conseiller for Laos.
Vientiane–Suvanakhet by plane.
Suvanakhet–Pakse by convoy.
Pakse–Saigon by courier plane.

January is a good time to travel in Laos because it is in the middle of the dry season. Therefore roads and mountain trails are all open, and one can reach almost any desired point by horseback. The weather is clear and cold in most regions with occasional frosts in the mountain areas such as Xieng Khouang and Pakson (near Pakse). The lack of rain gives the countryside a dry brown look which is replaced by lush green in the rainy season. The beauty of the forests in the north is enhanced in late January by the pink of blossoming cherry trees.

VIENTIANE

Vientiane is the principal town of northern Laos. It is located on the Mekong and is the seat of the French Government, with the Conseiller's mansion overlooking the river and Siam on the other side. (The French administration in Laos is technically advisory to a Laotian administration. Each district capital has its Laotian administrator and its French conseiller. Each such town also has a garrison of French and Laotian troops. Most transport facilities, planes, etc., are in French hands.)

Like all towns of Indochina, there is in Vientiane a central market to which people from the countryside bring garden produce for sale in the mornings and which gradually closes down by noon. This market is more colorful than those in Vietnam owing to the silk and brocaded skirts worn by the Laotian women and their characteristic off-center chignons often decorated with solid gold pins and circlets.

The shopping street of Vientiane is not more than a couple of blocks long. As might be expected, many of the shopkeepers are Chinese. The shops include a number of American and British goods including toilet articles (soap, toothpaste), ink, etc. These goods come in from Siam across the Mekong in exchange for raw materials from Laos. The exchange rate is said to be 1 tical for 2 to 3 piastres.

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[1] Received February 28, 1949.

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The French maintain an information hall across from the market place, and this is staffed by a French chief and a Laotian chief and a staff of three or four Laotians. They issue a mimeographed news sheet in Laotian every few days and publish a more ambitious journal every month or so. A newspaper reading room and photo-display hall take up the main floor, while offices of the staff occupy the upstairs.

The chief justice of the tribunal in Vientiane, Mr. Ourot, is a Laotian and also a French citizen. He was the delegate of Laos to the Asian Conference in New Delhi in 1947. His cousin, Ouneua, works in the Maison d'Information, speaks good French, and assisted the writer in his visits to villages and temples in and around Vientiane.

The most impressive feature about Vientiane—and all of northern Laos visited by the writer—is the friendliness of the relations between the French and the Laotians. This is in very marked contrast to the picture in either Saigon or Hanoi. Ouneua made an interesting remark in this connection: "Before the war the French did little for Laos (they had always favored Annam), but during the war we were faithful to France and now she is doing much for us." There is little doubt that Laos feels she has a good deal to gain from French protection. Laotians are afraid of Siam's expansionist designs from bitter experience and they also fear Vietnamese domination. Being a region of sparse population, they are in no condition to fend off either pressure unaided.

Until recently, there was an Annamese[2] community in Vientiane which supplied the local market with vegetables and some services. (The Laotians produce chiefly for home consumption, not for sale; the Annamese—from the French point of view at least—served a useful function by providing market goods and services.) But when the Vietnamese took over after the Japanese and then the French defeated them in this region, most of the Annamese crossed the river into Siam. Their deserted truck farms can still be seen in the vicinity of Vientiane.

Visits were made to two Laotian villages. These are strung along the river almost continuously and are to be found more sparsely inland. They consist of groups of bamboo-walled, thatch-roofed dwellings set up 6 or 8 feet from the ground on solid wood piles. Each homestead includes a plot of household land, a barn, a rice granary, also set up off the ground, a chicken coop (bamboo), a fine loom for weaving silk skirt materials and, by the river, a small vegetable plot on the riverbank as well as in the house yard. Each family has one or more rice fields some distance from the house. Many villages have a blacksmith who works at a forge, the heat of which is maintained by bamboo piston bellows. Each village has a headman who handles relations with the government. He seems to work without recompense but this is not certain.

On the occasion of feasts for various occasions, the neighborhood women foregather to prepare the necessary food. The cooking fires for such communal eating are laid in pits dug in the earth in such a way that the broad-beamed pot may be laid over a hole which has a short trench leading to it for draught.

The beautiful weaving of the area is done by the women; every young woman learns the art and makes her own materials. The silks are dyed at home, and it is common to see stained hands, especially indigo stained ones, in the village. Dyes other than blue and brown are purchased from Chinese—bright reds, oranges, etc. The decorative 6- to 8-inch bands at top and bottom of the skirts are woven separately and then sewn on the main skirt material. The bands usually include designs in silver and gold thread. A good skirt is valued at 400 to 700 piastres, and the remarkable thing about Vientiane and other places in northern Laos is the fact that every woman has a number of these fine garments and wears one daily to market—or even about the house.

A great deal of gold jewelry is also worn. This is said to be a form of investment, but it is also most decorative set in the black chignon of a Laotian lady or as earrings, necklace or bracelet.

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[2] In this report the term Annamese is used to refer to the prewar settlers in Laos in contrast to the term Vietnamese, used to refer to the politically conscious members of the new state of Vietnam made up of the former coastal states of Tonkin, Annam, and Cochinchina.

Some of the implements of the village are fundamentally of the same pattern as found throughout East Asia, as, for example, the foot-powered rice pounder and the broad round iron cooking pot.

One enters a farmhouse by bamboo ladder or steep wood stairs and comes into a room with a wood floor and with bamboo mat covering here and there. If one has footgear, it is usually removed before walking around. People sit on the floor or on low round bamboo stools which look rather like inverted baskets.

Many houses have a wooden chair or two which may be brought out for city guests. There is usually a stone fire grate somewhere in the main room where light cooking is done. This is in addition to outdoor fire places.

People in villages are friendly to visiting strangers but unless specifically approached make little effort to inquire of them who they are or why they are there. They neither crowd around one nor run away. This take-it-or-leave-it attitude is said to be characteristic of the area. Nor is there much of a tendency toward hierarchy in the villages. Visitors of various ranks are treated equally. This is reported to be in contrast to Vietnam where rank is most important, and where strangers are suspect until explained.

Another contrast to Vietnam is that special artisans do not seem to be characteristic of Laos. In each family the basic needs are supplied: food, clothing, drink. Ironworking is a specialty and so is silverworking and goldworking. But in the towns of Laos it is the Chinese and Annamites who supply the special services and manage the shops. The French often complain that the Laotian makes a poor worker because he does not care to work after he has supplied his needs or acquired enough money to buy the few things he wants to purchase. For this reason, houseboys and clerks in French households and government offices were often Annamites. Since the war, however, a definite effort is being made by the French to train Laotians for government work at all levels so that there need be no dependency on Annamites. The difficulties are threefold: that Laotians speak only Laotian; that they are as a whole untrained for government administrative desk work, and that many are not especially anxious to take it on in the industrious, conscientious way of the Annamite. The whole picture is somewhat reminiscent of the easygoing way of government action in Siam and the French find it difficult to have to let such a system operate in their domain. However, they are beginning to do so of political necessity.

In the villages no one speaks French, and in the town of Vientiane many do not do so either. English is practically unknown. Most villagers are also illiterate in both French and Laotian. On the other hand there are schools in Vientiane, and both French and Laotian authorities are encouraging parents to send their children to school.

Vientiane is a center of Buddhist study, with many monks and a Buddhist Institute, which publishes Buddhist texts, historical documents, and some secular folk material, such as songs and stories. Most of the *wats* have their tales of Siamese plundering. It was from Wat Phra Keo that the Siamese stole the "Emerald" Buddha now in Wat Phra Keo in Bangkok.

The French Conseiller of Laos has a Laotian wife and children, but the wife does not participate as hostess at dinner parties. It is possible that this is because she does not wish to, since the Conseiller's dinner parties are mostly of male officials, both local and visiting, and because he has a good staff of servants and may not care to mix his official activity with his private home life. However, it is interesting that during my stay as a guest in his house I was never introduced to his wife.

Despite the remoteness of Vientiane from Saigon, let alone Paris, the Conseiller and his various confrères make a point of maintaining French cultural standards. Every evening the men dress in white suits with ties and coats. All the amenities of French social life are preserved—intelligent conversation, "politesse," well-cooked food properly served, after-dinner coffee and liqueurs.

Vientiane has no centers of entertainment such as cafes, dance halls, and movies (at least I did not see any). It is definitely a country town despite its importance as an administrative center for Laos. The shops also are small, and none carries a very large supply or variety of goods.

XIENG KHOUANG

The French Conseiller kindly arranged for me to be flown by his Piper Cub to Xieng Khouang, the capital town of Tranninh, a high plateau and mountain area northeast of Vientiane. It is about an hour's flight over high mountains. Looking down from the plane, one sees here and there at widely separated intervals a small clearing in the forest and half a dozen or so thatched roofs, a village of one of the mountain peoples. Otherwise the mountains are densely forested and intersected by streams which feed the exaggeratedly meandering streams of the plains which in turn feed the Mekong, mother of rivers.

The pilot of the plane was a ruddy-faced Corsican, one of a large number of men from that island in Indochina. And he knew many of the Corsicans of Saigon, such as Rosselli, the manager of the Continental Palace. The numerous Corsicans in Indochina maintain a considerable degree of ethnic solidarity.

The Tranninh plateau is a high region surrounded by mountains and is reminiscent of regions in Wyoming or Colorado. The air is cool, often cold, and the days bright once the morning mists have lifted.

At the small airfield a few Laotian soldiers and a French officer are stationed. A Junker on the field had just brought up Saikham, the Laotian district chief of Tranninh from Vientiane.

In Xieng Khouang is the French Conseiller for the Laotian administrator (Saikham) and the Meo chief (Touby). The French conseiller is a Free Frenchman whose previous post for many years was Africa. This is not unusual in Indochina, where the old Vichy personnel has been largely replaced by De Gaulle men—and most of these early administration adherents were in Africa. He chafes a bit under the French indirect rule operating in Xieng Khouang, since he feels he could administer better directly. It is possible that the African background of many French officials in Indochina may be the cause of some of the administrative difficulties and clashes of temperament in Vietnam. In Xieng Khouang, however, M. Pazat seemed to be doing well and his relations with the ranking Laotian and Meo chiefs appeared to be good.

Tranninh is a really remote region—away from all big centers, isolated by mountains, and lacking rich natural resources to attract foreign exploiters. Nevertheless, it has had a troubled history and has been invaded in the past few hundred years by Chinese, by Annamese, and by Siamese. The Siamese invasion of 1892 seems to have been especially terrible, the Siamese taking off thousands of Laotians to Siam as slaves, killing others and generally pillaging the country. During the last war, the Japanese came in, then the Vietminh. And yet today the villages look as if they had rested undisturbed for centuries.

There is also evidence of earlier cultures in the area in the form of stone monuments, in particular a series of great stone funeral urns, 4 to 5 feet high with sides 5 to 6 inches thick, hewn from solid rock and placed in rough order along a ridge around a large crematorium set in a partially natural cave with a hole in the top for draught.[3]

Today the peoples of the district include three principal groups: the Laotian in the plains, the Kha or Phuteng in the hills, and the Meo high in the mountains. This altitude distribution of the three groups seems to be fairly consistent in this area of Laos. In Xieng Khouang, there are also some Chinese, some Tonkinese and a very few French. (Not counting a small military establishment). The Tonkinese still in Xieng Khouang are mostly second and third generation in the district. One or two settlements of Annamites who were mostly Vietminh have been evacuated and Meo who have come down from the mountains are now settled in their houses.

Xieng Khouang is a little country district town with the houses and offices of the French resident, the Laotian administrator and a military garrison. There are a few shops and a small central market, which has mainly edibles for sale each morning. A few manufactured items are sold by Chinese. The food products sold by Laotians and Meo

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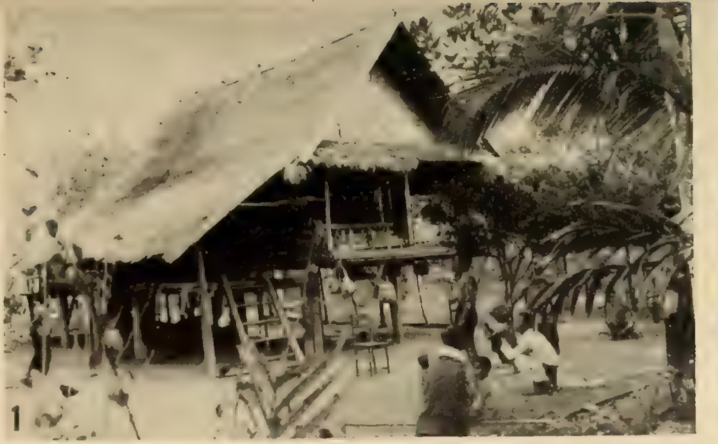
[3] These are fully described by Mlle. Colani in her publication *Megalithes du Haut Laos*, Paris, 1935.



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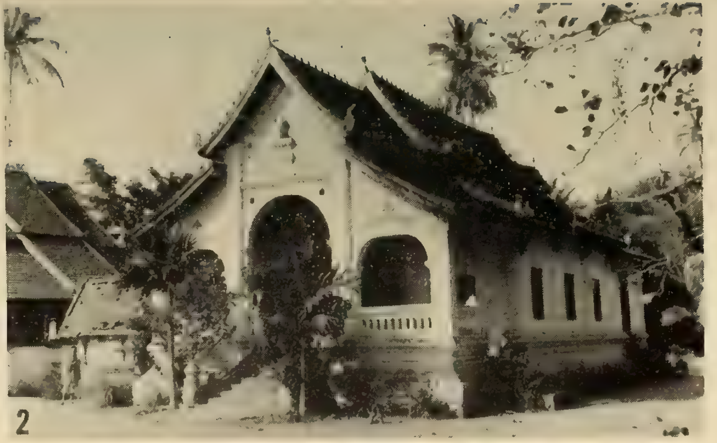

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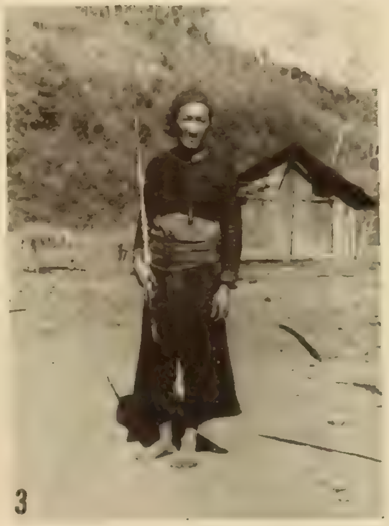

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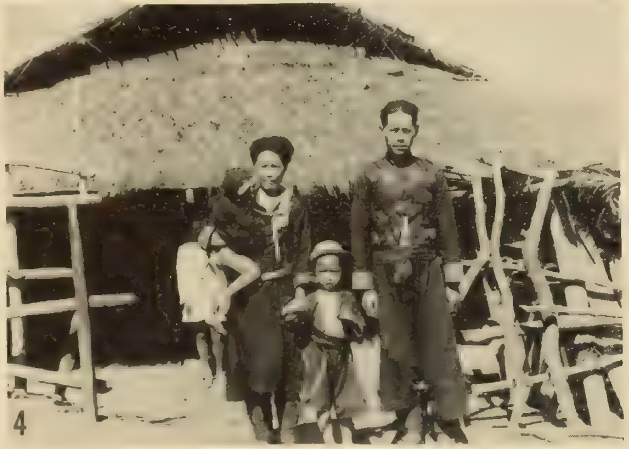

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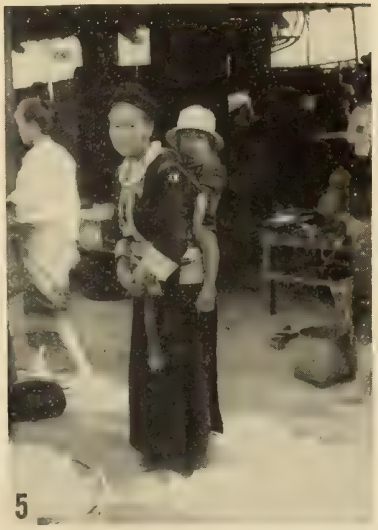

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FIG. 1.—Mountain Laos (or Kha?) house, a day's journey from Luang Prabang. FIG. 2.—Buddhist wat, or temple, in northern Laos. FIG. 3.—Meo with home-made gun. FIG. 4.—Meo family. FIG. 5.—A Meo woman at market in Xieng Khouang. She wears a characteristic silver necklace and carries grandchild in Meo style. Laotian woman with typical chignon in background.

are brought to market by women on carrying poles (Laotian) and on baskets carried on the back (Meo). The ladies set their small stocks down in front of them and stand behind them till a purchaser comes to buy—after an hour or so most perishables are sold. No handicrafts such as basketry or woven materials are for sale in this rural market—only local vegetables and animal produce (chickens, ducks, meat) and the manufactured imported items of Chinese, such as flashlight batteries (U.S., dated 1945), shirts, socks, soap, and matches (Siamese and Chinese makes).

Even this rural spot bears the marks of French culture—a stretch of road with neat curbstone border, a few European-style residences for French officials past and present.

Travel in Tranninh is almost exclusively by horseback. I saw only two jeeps in Xieng Khouang except for a convoy of trucks which arrived during my stay. By means of horses supplied by M. Pazat the writer was able to visit Meo, Kha, and Laotian communities.

THE MEO

The Meo, a type of Chinese mountaineer, make a point of the fact that a straight line is the shortest distance between two points by long trails to and between villages which go straight up and down mountain sides, instead of around or zigzag. This makes horse travel an adventure, but the small mountain ponies of the district are remarkably sure-footed and the danger is not that the horse will slip but that the rider will slide off his back as he picks his way down a steep incline.

The Japanese made a serious error in their treatment of the Meo as an inferior people. As a result, the Meo disliked them and aided the French to fight them and also to drive out the Vietminh from Xieng Khouang after the war.

The Meo are most hospitable. When visitors ride up, they come out of the houses, some—of either sex and any age—take the reins of one's horse and lead it off to rest and food, others invite one in for a visit. Some houses have a few chairs for visitors, but most people squat on a small block of wood set on the ground near the fire. Tea is served to visitors, and then food. The food has much more meat in it than that of the average plains people—chicken, beef, pork.

Meo villages are high in the mountains and consist of a few thatch-roofed wood planked houses set square on the ground. The flooring is leveled-off earth. Inside these huts it is dark and smoky, there being a constant fire in a firepit in the main room and no windows other than one or two doors. The yard has dogs and numerous black-haired pigs and some chickens. The dogs and chickens are free to go in and out of the house, but the pigs are kept out. The dogs are literal scavengers. Whatever is left of any food is thrown to them and they hover anxiously for the next item. Old tea is just thrown on the floor. The family walks on this earth floor barefoot.

Provision is made for a spirit of the house in the form of paper, with bits of silver and gold leaf on it pasted on the wall. Travelers are blessed by the village sorcerer who ties a string about one's wrist while he chants and others come and touch one's arm to draw out evil influences. (This custom is basically Laotian and one may notice more Laotians and many French in Laos with bits of old string tied about the wrist for safety. The writer wore one himself for a while.[4]

The Meo are polygamous, it being fairly common for a man to have two or three wives; even young men of 25 or so may have two wives. On the basis of local observations and visits I think it possible that the second wife is often married about the time the first one is having her first child. Thus the second wife can relieve the first of various domestic duties, which include cooking, looking after family agriculture (Meo have a little) and, of course, looking after the needs of her husband. The one family where the writer met both wives seemed to be a happy one and this was attested to without solicitation by the husband's cousin. The wives are not sisters and often are not even from the same district. But Meo culture, throughout Tranninh at least, is remarkably constant despite the wide separation of villages and the existence of peoples of other cultures in between.

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[4] Cf., description of similar custom in Siam in Landon's *Southeast Asia: Crossroads of Religion*, p. 31.

The Meo grow opium poppies. Some opium is consumed by them, often in the form of chewing the dried buttons. Supposedly the production of opium is controlled by the French authorities, but both they and others are of the opinion that much illicit trade in opium also takes place. Some of this, doubtless, goes to Siam in payment for manufactured goods from England and the United States. Bangkok and Hong Kong seem to be ultimate trade centers.

The chief of the Meo, Touby, and his family have acquired a knowledge of French and one of them also speaks English. (He has studied in Hanoi and Saigon). Touby, who lives in Xieng Khouang, not on the mountain tops, is anxious to encourage education among his people and he not only urges children to go to school, but encourages night study in his own home where he provides light and books. He is himself anxious to acquire more knowledge of the world. He feels that until the Meo know French they will be neglected. Undoubtedly, if men like Touby develop among the Meo, these people may become important political leaders in Laos in the future. There is little evidence of the Laotians making similar efforts. Touby himself is the French recognized representative of Meo affairs today.

LAOTIANS

Visits were also made to Laotian and Kha communities near Xieng Khouang. The Laotians of Tranninh wear the characteristic Laotian dress and men often wear the panung. The local female head dress of off-center chignon is universal, there being no permanent waves or bobbed hair as seen in Vientiane. The language is, of course, Laotian. None the less, they have a number of mountain traits; the diet is influenced toward more meat than in the river valley areas. They are said to drink a great deal and the chewing of betel is fairly prevalent. In general theirs is an upland variety of the basic Laotian culture.

KHA

The Kha and Phuteng are a mountain people said to be like the Moi, basically Malayan in type. However, the Kha the writer saw were pretty much like Laotians except for a few individuals in one village who looked somewhat Negroid. The term Kha is used very loosely and seems to refer to any peoples in the mountain living at a primitive level who are not distinctly Meo in type (the term Kha is said to be resented as indicating savage or uncivilized; Phuteng is more acceptable). The clothing is Laotian, and so are the houses. They do have one notable cultural trait, drinking from the jar. The jar is filled with ashes and into this is poured rice liquor from a bamboo container. Then a series of thin bamboo sticks is placed in it through which one sucks up the liquor which is strained through the ashes. Girls act as hostesses and exchange drinks with one out of the same "straw".

Tranninh and other high regions of Indochina are centers of malaria and it is said to be the commonest disease of the area. Yaws is also common. And I noticed that many people, both French and Laotian, had the sniffles from the cold. It becomes very chilly at night and only warms up about mid-morning—then by afternoon it is so warm one sheds coat and sweater. The Laotians wear various home woven shawls in the morning and lay them aside in the afternoon.

LUANG PRABANG

After Xieng Khouang, the writer visited Luang Prabang, the royal capital. This is a sleepy, rundown little town with a single row of shops and dozens of temples (wats) in various degrees of disrepair. (Xieng Khouang had practically no wats, though at one time in history they are said to have had many.)

The king's residence is in Luang Prabang and a number of princely families live there. Like Vientiane, it is on the River Mekong. The French have a Counseiller du Roi here who resides in the Maison de France. The Sureté has a staff including two Frenchmen.

There is no electricity in Luang Prabang, since the powerhouse is still unrepaired since the war. Like all towns evacuated by the Chinese occupation forces, Luang Prabang was pretty well stripped. (Pakse also suffered badly in this regard.)

As in Vientiane, Luang Prabang has desolate areas once occupied by Tonkinese who were a part of Vietminh. In Luang Prabang their houses have been destroyed. It is possible that the general evacuation of the Tonkinese from Luang Prabang accounts in part for its rundown appearance.

Many old historic wats are to be found in Luang Prabang and the town has sentimental values as the royal capital. But in general appearance it is less impressive than Vientiane. There is no electricity in this city and practically no motor transport. Some of the few army vehicles still have U.S. Army written on each side.

The countryside is settled by Laotians in villages. In the mountains are to be found Phuteng and Meo in the same arrangement as in Tranninh—only more distant from the town because of the wide expanse of lowland.

I visited one of the allegedly Phuteng areas on horseback, but as in Tranninh it turned out to be basically Laotian. It was also peculiar in having no musical instruments in it—every proper Laotian village has the bamboo flute (khene), and in offering no hospitality. This was in marked contrast to the "Phuteng" village visited in Tranninh.

SOUTHERN LAOS

From Luang Prabang I returned to Vientiane and then went on to Suvanakhet. This is a town on the Mekong with a heavy contingent of military including trucks and jeeps. It has a distinctly urban aspect in contrast to Luang Prabang and Vientane with many shops and even a couple of European-style restaurants. More girls had their hair waved.

The head of the Sureté here however is Laotian and a very pleasant individual who provided the hospitality of his house. Wats are less in evidence in Suvanakhet than in Luang Prabang or Vientiane.

A convoy was taken from Suvanakhet to Pakse. It began as three open trucks, but one broke down so we ended with two. Each had a fair complement of armed soldiers, both French and Laotian. Here in the south of Laos things are not so relaxed and peaceful as in northern Laos. Similarly, one could not ride through the forest with the same ease as in the Tranninh and Luang Prabang areas.

The countryside is more or less level, lightly forested and with here and there a rather poor village. The people one sees are poorly dressed in contrast to the Lao and Meo people, especially women, wearing well made and culturally distinct clothing on the public roads of Tranninh.

Pakse turned out to be another Suvanakhet, only more so. More Chinese shops, more French army, more restaurants and even a house of prostitution and an opium den. The town Laotians wear European clothes or rather poor quality skirts—silver-colored thread instead of thread of silver in the brocades. Bobbed hair and permanent waves are almost universal among the young women. Pakse is "acculturated" by contrast with Vientiane.

There are a large number of Annamites in Pakse and one large community on the far side of the river.

The shops contain a wide variety of English and American goods, including items rare in Saigon; e.g., safety razors and razor blades. The prices for manufactured articles are not especially high. (In Tranninh imported goods such as thread are said to be exorbitant.) Presumably many of these goods find their way here from Siam.

On the whole, the impression one gains from a trip to Laos after residence in Saigon and Siam and Hanoi is one of peacefulness and harmonious relations between French and Laotians. This is especially true in the North, where Laotian culture is also strongest. In the south, Chinese and Annamites exist in larger numbers and Vietminh activity also seems to exist. One sees more French military. The small towns are more urban and commercial in a Western sense.

Laos is an area of a wide variety of peoples especially in the mountain areas and in the north, each with its own distinctive language and culture. The minority problem spoken of by the French is a real one. The Meo may well become a progressive and politically important minority group in Laos in a generation.

The people of Laos, French and Laotian alike, take pride in the country, the people, and the culture, and make no effort to hide their preference for Laos and Laotians to Vietnamese or Siamese or Chinese.

French administration in the area is indirect and there seems to be a conscious effort to make it really so. The Laotians in turn seem to fear Vietnamese and Siamese and appreciate French protection, a general picture quite different from the present bitter relations in Vietnam. Little evidence was seen of a Free Laos movement and one is led to believe that this is largely a Siamese-Vietnamese sponsored movement without much active popular support in Laos itself.[5]

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[5] For those interested, recent articles on the peoples and cultures of Laos have appeared in a number of journals published in Indochina; for example, the Bulletin des Amis du Laos, which appeared annually from 1937 to 1940; the Bulletin de l'Institut Indochinois pour l'Etude de l'Homme (e.g., Nguyen-Xuan-Nguyen, *Contribution à l'ètude des tatouages au Laos*, **4:** 99–111, 1942); and the Bulletin de l'Ecole Française d'Extrême Orient (e.g., Paul Lévy, *Les traces de l'introduction du Bouddhism à Luang Prabang*, **40:** 411–424, 1940). A good article on Kha religion is Karl Izikowitz's *Fastening the soul—some religious traits among the Lamet* (*French Indo-China*), Göteborgs Högskoles Arrskrift **47:** (14): 3–32, 1941.

BOTANY.—*Seven new species of Lobelioideae* (*Campanulaceae*).[1] ROGERS McVAUGH, University of Michigan. (Communicated by E. P. KILLIP.)

In the course of recent work on the American genera of Lobelioideae (Campanulaceae), several species apparently new to science have come to my attention. Descriptions based on all available materials of these species are given below. I am indebted to Dr. José Cuatrecasas and to the authorities of the Chicago Natural History Museum, as well as to E. P. Killip of the U. S. National Museum, for the opportunity to study the large Colombian collection made by Dr. Cuatrecasas. Dr. Julian A. Steyermark has put at my disposal his collections from Ecuador and from Venezuela, including two species which I have already described elsewhere (Brittonia **6:** 471, 474. 1949). P. H. Allen's collections are particularly interesting because they represent a relatively large addition to a small subsection of *Centropogon* (*Colombiani*), which has recently been intensively studied. For Joseph A. Ewan's South American collections (some of which have already been described in Brittonia **6:** 457, 467. 1949) I am indebted to the collector himself and to the U. S. National Arboretum, in whose herbarium the first set of the collections is deposited.

1. **Lobelia gladiaria** McVaugh, sp. nov.

Sect. *Hemipogon*; herba perennis glabra, foliis linearibus; corollae tubus fenestratus, 5.5–6.5 mm longus, non obliquus; filamenta 4.5–6 mm longa; antherarum 3 superiores apice papillosae; calycis lobi 2–3.5 mm longi appressi, denticulati; semina minute lineata.

Slender herbaceous perennial from a somewhat elongated and woody persistent rootstock, the weakly erect stems up to 60 cm long, 2 mm in diameter at base; plants glabrous except the pedicels, leafy below the middle, the 10–15 leaves linear, straight and stiff (hence *gladiaria*, of or pertaining to swords), 1.2–3 mm wide, 5–10 cm long, 30–50 times as long as wide, attenuate to apex and to the sessile base, slightly paler beneath, the margins somewhat involute, minutely denticulate with 1–2 teeth per cm; raceme up to about 20 cm long, secund, loosely few- to 20-flowered, pedunculate, the stem naked for 5–8 cm below it; pedicels slender, stiffly erect, 46 mm long in fruit, minutely hispidulous, bibracteolate near bases, the bracteoles linear or filiform, dark, appressed, 0.6–0.8 mm long; bracts subulate, denticulate, appressed, the lowest up to 6 mm long; flower about 15 mm long, including hypanthium; corolla "blue-violet" (Moore & Wood), apparently with no white "eye" but the tube pale ventrally, glabrous without (the lower lip strongly roughened at base), hairy within near base; corolla-tube fenestrate laterally, 5.5–6.5 mm long, nearly cylindric, about 1.5 mm thick; lobes of the lower lip elliptic, about 1.5–2 mm wide, 5 mm long, somewhat reflexed, the two upper lobes lanceolate, erect, about 0.8 mm wide at base, 4 mm long, attenuate; filament-tube 4.5–6.5 mm long, the filaments united less than 1 mm distally, otherwise distinct, ciliate near bases; anther-tube bluish gray, 1.9–2.5 mm long, the long anthers with minute white stiff hairs near tips and extremely short white papillose tufts at the very tips; short anthers with dense white apical tufts 0.4 mm long; hypanthium in anthesis turbinate, tapering at base, about

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[1] Received February 24, 1949.

1.5–2 mm wide and high when pressed, in fruit similar, 2.5 mm across, the capsule 5 mm long, ellipsoid, about two-fifths inferior; calyx-lobes narrowly triangular, sharply pointed, denticulate, appressed in anthesis and in fruit, about 0.7–1 mm wide at base, 2–3.5 mm long; seeds ellipsoid, brown, smooth but with very fine longitudinal lines, 0.7 mm long.

Mexico: Hidalgo: Dry ravine and ridges in pine-oak woods near Rancho San Alejo between Tulancingo and Acaxochitlàn, alt. 7,000 feet, September 6, 1948, *H. E. Moore, Jr., & C. E. Wood, Jr., 4875* (TYPE, in herb. University of Michigan); about 2 km above Apulco on road to Agua Blanca, *Moore & Wood 4892* (herb. Bailey Hortorium).

This plant is evidently a member of the sect. *Hemipogon* as defined in the North American Flora **32A:** 45–65. 1943, but does not seem to have conspicuously close affinities with any single species. In general appearance it suggests *L. dielsiana*, of Guerrero, but in that species the corolla-tube is not fenestrate, the ovary is almost entirely superior and the calyx-lobes are much longer. The corolla of *L. gladiaria* suggests that of a small-flowered plant of *L. hartwegi*, but in other ways the plants are quite different.

2. **Siphocampylus uncipes** McVaugh, sp. nov.

Suffrutex caulibus tenuissimis, foliorum pagina superiore et calycis lobis exceptis glaber, foliis lanceolatis, attenuatis, subcordatis, margine fimbriatis, pedicellis medio bibracteolatis, floribus 3 cm longis; corollae tubus 15 mm longus; filamenta 23 mm longa.

Suffruticose terrestrial plant up to at least 60 cm. high, the glabrous stems very slender (2–2.5 mm in diameter at base including the corky bark) but "erectish" (Steyermark), with long internodes (up to 5 cm) and narrow leaves; leaves glabrous beneath, very minutely roughened above with stiff sharp colorless hairs about 0.1 mm long, the plants otherwise glabrous except the tips of the calyx-lobes; blades 0.8–1.5 cm wide, 2–5 cm long, 4–7 times as long as wide, lanceolate, subcordate at base or the younger ones rounded, all long-attenuate to a slender acumen 1 mm wide and 8–12 mm long; petioles flexuous, 0.7–1.7 cm long, very slender (less than 0.5 mm thick); margins fimbriate-dentate with 6–8 teeth per cm, the teeth slenderly triangular with dark callose tips, up to 3 mm high, the longest ones near base of blade and often spreading nearly at right angles or even, on the basal lobes of subcordate blades, directed backward; upper teeth more slender, shorter, appressed; flowers 10–12, in the axils of the somewhat reduced upper leaves (or a few of the axils bearing 1–3-flowered lateral branches), the floriferous part of the stem-axis somewhat zigzag; pedicels divaricate in anthesis and in fruit, 25–55 mm long and 0.5 mm in diameter, at maturity abruptly decurved distally (whence *uncipes*), bibracteolate near the middle, the bracteoles filiform, about 1.5 mm long; flower about 3 cm long; corolla "blood red, lobes orange-yellow" (Steyermark); tube 15 mm long, contracted just above base to a width of 1.5–2 mm (when pressed), thence gradually enlarged to a width of 4.5–6.5 mm just below the bases of the lobes, the dorsal side convex; lobes linear-attenuate, apparently curled outward in anthesis, the dorsal 2 mm wide at base, 8–10 mm long; lateral and ventral lobes about 1.5 mm wide, 8 mm long; filament-tube glabrous, 23 mm long, exserted, the filaments distinct near base and attached to the narrow basal portion of the corolla; anther-tube "blackish" (Steyermark), drying pale gray and the connectives yellowish white, 4.5–5 mm long, 1.5 mm thick, the long anthers with a few stiff white hairs near tips, the white apical tufts of the short anthers about 1 mm long; hypanthium in anthesis turbinate, about 3 mm long and wide when pressed, acute at base, the calyx-lobes erect, subulate, denticulate, 2–4.5 mm long and 0.7 mm wide at base, strigose near tips with hairs like those of the leaves; capsule campanulate, about 4 mm in diameter, 8–9 mm long, three-fourths inferior; seeds oblong or oblong-ovoid, 0.6–0.8 mm long, minutely pitted-reticulate with isodiametric or slightly elongated flat-bottomed pits.

Ecuador: El Oro: between Curtincapa and Guagra Uma, 8 miles northeast of Curtincapa on southwest slopes leading to Chapel, alt. 1,500–2,895 m, dry rocky ground, August 16, 1943, *J. A. Steyermark 53922* (TYPE, in herb. University of Michigan; duplicate in herb. Chicago Natural History Museum).

This plant evidently is related to the group of Peruvian species exemplified by *Siphocampylus comosus*, perhaps *S. nobilis*, and perhaps also the Brazilian *S. igneus*. These species have relatively small red and yellow flowers, often in the axils of normal leaves like those of *Siphocampylus uncipes*.

3. **Centropogon uncialis** McVaugh, sp. nov.

Sect. *Eucentropogon*; herba hirsutula pilis septatis 0.5–0.7 mm longis, floribus 27 mm longis, in axillis foliorum normalium solitariis; calycis lobi triangulares, 5.5–7 mm longi; stamina glabra; filamenta 19–21 mm longa; antherarum 2 inferiores apice cornutae.

Succulent hairy terrestrial herb 50 cm high with coarse thin leaves; whole plant more or less thickly hirsutulous with colorless or sordid sharp 3–5-celled flaccid hairs 0.5–0.7 mm long which collapse on drying; leaves green both sides, strigose-hirsutulous above (often thinly so), rather densely hirsutulous beneath, especially on the veins; blades 3–8 cm wide, 15–18 cm long, 2 (or 4–5) times as long as wide in the material seen, narrowly or broadly elliptic, acute at tip, rounded or acute at base and then attenuate and long-decurrent on the petiole, the actual petiole often very short, 5–15 mm long, 1.5–2 mm in diameter, hirsutulous; margins irregularly serrate-dentate or denticulate, the teeth callose-tipped, 8–10 per cm, 0.5–1 (–1.5) mm high; flowers 15 or more, in the axils of the little-reduced upper leaves; pedicels hirsutulous, 35–40 mm long and about 0.8 mm in diameter, ascending in flower, weakly spreading in fruit; bracteoles filiform, hairy, 1.5–2 mm long, at the middle of the pedicel or a little below this; flower about 27 mm long (*uncialis*), including hypanthium; corolla "red" (Haught), sparsely hairy without (the hairs as on the foliage), glabrous within; tube 17–18 mm long, slightly bent at the summit of the narrow basal portion, contracted immediately above base to a cylindrical tubular portion about 1.5 mm wide (when pressed) and 3 mm long, thence gradually enlarged to the mouth, where 6 mm wide when pressed; lobes triangular-falcate, the dorsal 2.3–2.7 mm wide at base, 5 mm long, the lateral and ventral similar, smaller, the ventral separate, 4–4.5 mm long; filament-tube 19–21 mm long, glabrous, slightly exserted, the filaments free at very base (3 mm) and fused to the corolla only below the narrow part of the tube; anther-tube 4–4.5 mm long, 1.5 mm in diameter, glabrous, drying pale reddish brown (not slate-gray), the two short anthers with apical triangular appendage 1.5 mm long; hypanthium in anthesis rounded, about as long as wide, hairy, 5–6 mm wide when pressed, the lobes triangular, appressed, narrowly acute, entire or minutely callose, hirsutulous, 2–2.5 mm wide at base (sinuses narrow, acute), 5.5–7 mm long; fruit dry, apparently membranaceous, depressed-globose, about 10 mm in diameter; seeds light brown, oblong-ovoid, flattened, about 0.6–0.8 mm long, strikingly reticulate with about 15 minute flat-bottomed pits across the broad diameter.

Colombia: Cundinamarca: Between Pacho and Río Negro, "carretera y alrededores," alt. 1,000–1,200 m, February 22–26, 1942, *H. García Barriga 10744* (type, in herb. University of Michigan); Pacho-Paime highway, alt. 2,200 m, August 13, 1947, *Oscar Haught 6072* (U. S. Nat. Herb.).

The two collections cited above agree in all particulars except that in the type the leaves are narrowly elliptic, 3–3.5 cm wide, and 4–5 times as long as wide; in Haught's collection the blades are 6.5–8 cm wide and about twice as long. Apparently no other species among the cornute Centropogons has the very small flowers (in the axils of normal foliage leaves) and the conspicuous hirsute pubescence of *C. uncialis*.

4. **Centropogon vittariaefolius** McVaugh, sp. nov.

Brevilimbatorum; frutex 2–3 metralis, foliis linearibus 2–3 mm latis, 50–80 mm longis, pilis stellatis, staminibus 60–65 mm longis, corollae tubo recto, 42 mm longo.

Much-branched shrub up to 2–3 m high with very many narrowly linear leaves; branches thickly tomentose with rusty-brown branched hairs, these blackening in age; leaves close together (often 50 leaves on the terminal 8 cm of a branchlet), linear, 2–3 mm wide, 50–80 mm long, slightly narrowed and obscurely mucronate at tip, attenuate to a tomentose petiolar base 2–4 mm long; blades green, sparsely stellate above, the midrib impressed, the lateral veins, if any, imperceptible to the eye; lower surface with prominently raised midrib almost obscured by abundant rufous tomentum (this forming a conspicuous median line), and scattered hairs elsewhere; hairs on this surface and the midrib stipitate, appearing stellate, the arms mostly 3–10 on each hair, up to 0.5 mm long, arising together from a single enlarged node; margins of the blades very slightly involute, denticulate, the teeth slightly intramarginal, callose, dark, often 3–4 mm apart; flowers axillary, 1 or 2 to a branch, on weakly spreading tomentose pedicels 2–4 cm long and 1 mm in diameter (excluding the hairs); bracteoles basal, about 0.5 mm long; flower about 6.5 cm long; corolla "scarlet"

(Ewan), glabrous within, the outer surface rather thickly beset with hairs like those of the leaves or slightly smaller; tube 40–43 mm long, straight and relatively narrow, contracted above base for a distance of 5–8 mm, then gradually widened to near the base of the lobes, where 6 mm wide when pressed (the whole very narrowly funnelform); lobes falcate, the dorsal 3.5 mm wide at base and 12–15 mm long, the lateral and ventral united into a lower lip 8–9 mm long, their free portions narrowly triangular, 5 mm long or less; filament-tube about 55 mm long, exserted about 1.5 cm, pilose with white simple hairs up to 0.7 mm long which collapse in drying, the filaments distinct at base and there fused with the narrow part of the corolla-tube for about 5 mm; anther-tube about 7 mm long, bluish gray, sparingly hirsute distally with sordid straight simple hairs 2 mm long; apical tufts of the short anthers apparently sparse, white, about 1.5 mm long; hypanthium in anthesis depressed-hemispheric, 5–6 mm across, tomentose, the lobes triangular with narrow acute tips, stellate, denticulate, 1.5 mm long and wide, separated by broad sinuses; fruit a dry "berry," not seen mature, probably about 6–7 mm across and 4 mm high, the hypanthium-rim about 1 mm high; seeds not seen.

Colombia: Antioquía: Páramo de Sonsón, above Sonsón, Cordillera Central, 2,930 m, scattered among paramillo brush, May 23, 1944, *J. A. Ewan 15707* (TYPE, in herb. University of Michigan; duplicate in herb. U. S. National Arboretum).

The specific name is given in reference to the appearance of the clustered leaves, each with its median rusty brown line, the whole suggesting the leaves of a small clump of *Vittaria*. No other known species has these narrowly linear leaves; the flowers also are unusually large for the group of species with short triangular-subulate calyx-lobes (e.g., *Centropogon ferrugineus*) to which *C. vittariaefolius* seems most closely related .

5. **Centropogon floricomus** McVaugh, sp. nov.

Colombianorum, C. gutierrezii affinis sed floribus parvioribus; corollae lobi dorsales 16–18 mm longi pilosi; filamenta 50–55 mm longa; calycis lobi 4–5 mm longi; pedicelli 2 bracteolis 1.5 mm longis praediti.

Weak terrestrial herb up to about 1 m high, the stems glabrous below, rather sparsely appressed-puberulent on the younger parts, the hairs white or colorless or sometimes purple-tinged, about 6-celled, attenuate, 0.2–0.4 mm long, crisped, extending to the pedicels and flowers, and to the petioles and the veins of the lower surfaces of the leaves; leaves (often pale purplish when young) green and glabrous above (or with a few hairs on the midvein at base), pale beneath, the surface glabrous and the veins puberulent; blades lance-ovate, petiolate, decreasing gradually in size to the tips of the branches, 4–10 cm long, 2.3–2.8 times as long as wide, rounded to subcordate at base, unequal-sided and slightly decurrent on the petiole, broadest near base or in the basal one-third, where 2–4 cm wide, thence attenuate to a narrow almost caudate tip 2 mm wide and up to 1 cm long (or in some leaves having the basal half or two-thirds ovate and the distal third gradually attenuate, the blade thus widest near the middle); petioles 1–2.5 cm long, up to 1 mm in diameter, puberulent; margins finely and shallowly serrate, the teeth somewhat irregularly spaced, 5–6 per cm, with dark callose points up to 0.5 mm long; flowers 10–12, in the axils of the upper leaves; pedicels 7–8 cm long and about 1 mm in diameter, sparsely puberulent, weakly spreading and flexuous in fruit (ascending in flower), abruptly decurved near tip in fruit and the capsule thus pendent; bracteoles about 3–5 mm above base, 0.5 mm wide and 1.5 mm long, pointed, puberulent; flower 6.5–7 cm long, including hypanthium; corolla "bright pink, tipped white" (Allen), the ventral side paler, and sometimes only the lateral and ventral lobes white; tube 40–46 mm long (measured to the lateral sinuses), glabrous within, puberulent without, straight or slightly bent at the summit of the narrow basal portion; basal portion cylindrical, 10–15 mm long, 2–4 mm wide when pressed, the tube beyond this expanding to the cylindrical or narrowly funnelform throat 6–9 mm wide when pressed; lobes linear, the dorsal straight, in flower usually appressed to and slightly surpassing the stamens, 1.5–1.8 mm wide (2–2.5 mm at base), 16–18 mm long, acute, often with a number of stiff hyaline hairs 0.5–0.7 mm long on the outer surface near tip; lateral and ventral lobes similar, shorter, 12–13 mm long, curled outward in anthesis, the ventral slightly separated from the rest and apparently set further back on the tube because of the deeper sinuses adjacent to it; filament-tube 50–55 mm long, longer than the corolla-tube but not appearing exserted because of the erect dorsal lobes, glabrous, the filaments distinct in the basal third and fused with the narrow proximal portion of the corolla-tube; anther-tube 7.5–8 mm long, "slate-gray" (Allen), glabrous, the two short anthers with dense terminal tufts of white hairs 1.5–2 mm long; hypanthium in anthesis campanulate or turbinate, acute at base, about 6 mm wide and 8–9 mm long when pressed, puberulent, the lobes arising from a rim about 1 mm high, the free parts acutely triangular with narrow dark spreading callose tips, entire or with one glandular tooth on each edge near base, puberulent, 2.5–3 mm wide at base, 4–5 mm long; corolla and stamens withering-persistent but finally breaking irregularly from the fruit about at maturity; fruit not seen mature, but apparently a pendent leathery somewhat inflated "berry," probably obovoid or nearly globose, 1–1.5 cm long; seeds about 0.6 mm long, reticulate-pitted, with small rounded pits in a coarse reticulum, probably ovoid-lenticular.

Panama: Bocas del Toro: Robalo trail, northern slopes of Cerro Horqueta, 6,000–7,000 feet, August 5–7, 1947, *P. H. Allen 4911* (TYPE, in herb. University of Michigan; duplicate in herb. Missouri Botanical Garden).

In appearance this species is not unlike *Centropogon gutierrezii*, which is restricted as far as known to the upper slopes of the great volcanoes of Costa Rica (e.g., Poas, Barba, Irazú). *Centropogon floricomus* may be distinguished easily from *C. gutierrezii* by its shorter calyx-lobes (4–5 mm instead of 10–22 mm) and much shorter bracteoles on the pedicels (1.5 mm as against 5–10 mm). The corollas and stamens of the two species are closely similar, except that the dorsal lobes in *C. floricomus* are shorter and less heavily pilose.

The addition of this and the following species increases to 16 the number of known species in Subsection *Colombiani*, Section *Wimmeriopsis* (see Brittonia **6**: 465–476, 1949).

6. **Centropogon leucocarpus** McVaugh, sp. nov.

Colombianorum; herba tenuis minute hispidula, foliis lanceolatis 1–2 cm latis, 4–5-plo longioribus quam latioribus, pedicellis ebracteolatis 3–4 cm longis; corollae tubus 23–24 mm longus; lobi attenuati, subaequales, 2.2–2.3 cm longi, non falcati; filamenta 28–29 mm longa; calycis lobi triangulares, 1.7–2 mm longi; bacca globosa, alba, diametro 5–6 mm.

Slender terrestrial herb to 75 cm high, all parts of the plant minutely hispidulous with erect or incurved white or colorless hairs 0.1 mm long, these rather sparse on the lower parts of the stem and the upper surfaces of the leaves but otherwise generally distributed; leaves green (or the youngest ones, like the young shoots, purplish), lanceolate, short-petiolate, the upper ones smaller; blades 1–2 cm wide, 3–10 cm long, 4–5 times as long as wide, rounded or obtusely angled at base and slightly decurrent on the petiole, broadest in the proximal third and thence tapering to the long-attenuate tip; petioles 0.4–1.4 cm long; margins shallowly serrate-dentate with (4–) 6–8 incurved, dark-tipped teeth per cm; flowers few (often 1–4) to a branch, in the axils of the upper leaves; pedicels slender and flexuous, somewhat ascending in anthesis and widely spreading in fruit, 3–4 cm long and about 0.7 mm in diameter; bracteoles wanting; flower slightly less than 4 cm long, including hypanthium; corolla "red" (Allen), drying purple, glabrous within, puberulent without with hairs like those of the vegetative parts but purplish; tube 23–24 mm long, slightly curved, slender, constricted above the base and there 1.5–2 mm wide when pressed, then enlarged, the distal two-thirds cylindrical or narrowly funnelform, 3.5–4.5 mm wide when pressed; lobes linear-attenuate with very slender almost caudate tips, subequal, about 1.5 mm wide at base, the dorsal straight, about 2.2 cm long, the lateral and ventral similar, somewhat curved (probably outward in the fresh flower), the ventral cut into the tube more deeply than the others and often 2.3 cm long; filament-tube 28–29 mm long, slightly exserted, glabrous, the filaments distinct near base and fused with the narrow proximal portion of the corolla-tube; anther-tube 4.5–5 mm long, gray (the commissures pale reddish brown when dry), glabrous except for a few short bristles near the tips of the longer anthers; terminal tufts of the short anthers white, dense, 1–1.1 mm long; hypanthium in anthesis campanulate, acute at base, 2.5–3 mm wide and 3.5–4 mm long when pressed, the calyx-lobes triangular, entire, 1.3–1.5 mm wide at base, 1.7–2 mm long; corolla and stamens withering-persistent on the fruit, which is a globose or oblate dry berry, "white" (Allen), 5–6 mm long and broad, crowned by the persistent sepals; seeds about 0.5 mm long, ovoid-lenticular, minutely reticulate with shallow flat-bottomed pits.

PANAMA: Chiriquí: Bajo Mono–Robalo trail, alt. 5,000–7,000 feet, western slopes of Cerro Horqueta, July 27, 1947, *P. H. Allen 4836* (TYPE, in herb. University of Michigan; duplicate in herb. Missouri Botanical Garden).

Centropogon costaricae is apparently closely related to *C. leucocarpus*, as suggested by the very similar corolla and stamens, the usually ebracteolate pedicels, and the white fruit. The leaves of the two species, however, are very different (lanceolate, 4–5 times as long as wide in *C. leucocarpus*; ovate, at most twice as long as wide in *C. costaricae*), and *C. costaricae* is usually glabrous almost throughout, with calyx-lobes 4–7 mm long (as against 1.7–2 mm long in *C. leucocarpus*).

7. **Burmeistera prunifolia** McVaugh, sp. nov.

Frutex, pilis luteis septatis superne vestitus; folia 3–4 cm longa, 2–3-plo longiora quam latiora, petiolis 2–3 mm longis; corollae tubus 18–19 mm longus, fere cylindricus; filamenta 27–28 mm longa; antherarum 2 inferiores apice villoso-barbatae, reliquae nudae; hypanthium campanulatum, basi attenuatum; calycis lobi 6–7 mm longi, patenti vel reflexi; bacca globosa diametro 4 mm.

Scrambling shrub, abundantly branched near the tips, the branches pendulous, angled, pustulate-roughened by the bases of old hairs; branchlets, young foliage and young flowers rather sparsely appressed-hirsute with thick-walled attenuate jointed (5–6-celled) dull yellowish hairs 0.4–0.8 mm long, these most abundant on the young branchlets, then rather early deciduous except for the slightly enlarged base; leaves numerous, thin (the internodes 0.7–1.5 cm long), glabrous above from the first, distichous (Cuatrecasas), violaceous beneath (Cuatrecasas), the lower surface with persistent scattered hairs especially on the veins; blades rather small, 1.3–2 cm wide, 3–4 cm long, 2–3 times as long as wide, ovate-lanceolate to ovate, rounded at base (occasionally subcordate), broadest well below the middle, gradually narrowed to an acute or broadly acuminate tip; petioles 2–3 mm long, 0.7 mm thick, hairy; margins very shallowly crenate with 1–3 intramarginal callosities per cm; flowers about 7–10, in the axils of upper leaves; pedicels 25–35 mm long, 0.7 mm in diameter, ebracteolate, sparsely hairy near base, weakly ascending or spreading in flower, spreading in fruit; flower 3 cm long; corolla "verde clara o con manchas palido violaceas" (Cuatrecasas), glabrous or with an occasional hair near the summit of the tube; tube 18–19 mm long, straight, cylindric or slightly narrowed toward the mouth, 2.5–3 mm wide when pressed flat; dorsal lobes elliptic, somewhat curved, 2.5–3 mm wide, 12 mm long, acute; lateral and ventral lobes ovate, acute, 3.5–4 mm wide, 7–10 mm long, forming a falcately decurved lower lip; filament-tube 27–28 mm long, glabrous or with a few long hairs distally, the filaments distinct at base, and fused to the corolla-tube for the basal 3 mm; anther-tube about 3 mm long and 2.5 mm thick, the long anthers glabrous, the short ones 2 mm long, glabrous except for the rather copious apical tufts of soft tangled white hairs 1 mm long; hypanthium in anthesis nearly or quite glabrous, campanulate, narrowed at base, a little longer than wide when pressed, 3–4 mm long, the lobes linear-attenuate, sparingly callose-denticulate, 1 mm wide at base, 6–7 mm long, nearly or quite glabrous, stellately spreading from the flower and fruit or slightly reflexed; fruit probably a dry small berry, white (Cuatrecasas), globose, crowned with the spreading calyx-lobes, about 4 mm in diameter; seeds ellipsoid-oblong, 0.7–0.9 mm long, with minutely pitted-reticulate surface, the pits slightly elongated.

COLOMBIA: El Valle: Cordillera Occidental, vertiente occidental, Hoya del Río Dígua, lado derecho, La Elsa, bosques, 1,000–1,200 m alt., November 9, 1943, *J. Cuatrecasas 15329* (TYPE, in herb. University of Michigan).

This species seems very different from any other previously described. In Wimmer's most recent study of the genus *Burmeistera* (Das Pflanzenreich IV.**276b**: 122–161. 1943) it would be treated as a member of the Section *Barbatae*, in which there are about eight other hairy species.

ZOOLOGY.—*On some western millipeds of the order Spirobolida.*[1] Ralph V. Chamberlin, University of Utah. (Communicated by C. F. W. Muesebeck.)

The present paper aims to present some results of a review of western, chiefly Californian, millipeds of the order Spirobolida. The genera represented are regarded as falling into two families, the Spirobolidae sens. str. and the Atopetholidae, here more restricted than in earlier usage.

The study has been based primarily upon material in my own collection now housed at the University of Utah where types of the new forms are for the present retained. The diagnoses of new forms are based in the main upon features of the male gonopods and are made brief, more detailed accounts being reserved for later elaboration.[2]

Family Spirobolidae

This family as now conceived by the author is superficially characterized by having the second tergite produced conspicuously below the level of the end of the collum on each side. The gonopods are typically short and compact, without segmentation though sometimes with a free inner piece, each articulated to a conspicuously developed and strongly muscled basal support.

The genera occurring north of Mexico are *Spirobolus*, *Hiltonius*, *Auxobolus*, n. gen., *Californibolus*, and *Tylobolus*. In Mexico, in addition to *Hiltonius* and *Spirobolus*, the genera *Messicobolus* and *Aztecolus* at present represent the family. Attention here is given chiefly to species that in recent years have generally been referred to *Tylobolus* but that here are distributed among several genera.

Auxobolus, n. gen.

This genus is proposed for a group of species differing from those of *Tylobolus* and *Californibolus* in that the coxal plates of the anterior gonopods but little, or sometimes not at all, exceed the sternite instead of meeting broadly in front of and caudad of it as they do in the other two general mentioned. From *Californibolus* it also differs in having the telopodite of the anterior gonopods distally strongly bent or subuncate instead of remaining essentially straight, and from *Tylobolus* in the form of the posterior gonopods. Orthotype: *Auxobolus ergus*, n. sp.

Auxobolus ergus, n. sp.

Figs. 5–7

General color of the body reddish to chocolate-brown, with dark, nearly black, annuli, which are wider dorsally than down the sides. Legs reddish brown or chestnut. Darker individuals appear almost mahogany colored.

Clypeal foveolae 4—4. Eyes widely separated, their ocelli typically in 6 or 7 series.

Collum narrowed down the sides, margined along the anterior border below the level of the eyes, otherwise smooth or in some females with a shallow transverse furrow in front of the caudal border, this furrow almost sulciform toward its ends. The second tergite extending well below the lower end of the collum.

On the ordinary tergites the segmental sulcus is fine but distinct throughout; it bends forward to and embraces the repugnatorial pore. Segments strongly longitudinally striate beneath, but a wide space below each pore smooth and free of striae.

Last tergite essentially smooth except for a shallow transverse furrow in front of the caudal end. Anal valves prominent, smooth.

The characteristic features of the gonopods of the male are shown in Figs. 1, 2, and 3.

Number of segments, 51–53.

Length of male, 80 to 90 mm; width, 7 to 8 mm. Width of female up to 10 mm.

Type locality.—California: Tollhouse. Males and females taken March 23, 1941, by S. and D. Mulaik.

Other records.—California: Madero County; Kern County, 7 miles north of Glenvilles; also Clements. All collected by the Mulaiks in March 1941.

Auxobolus castaneus (Chamberlin)

Tylobolus castaneus Chamberlin, Proc. Biol. Soc. Washington **31**: 166. 1918.

Type locality.—California: Brookdale.

Auxobolus claremontus (Chamberlin)

Tylobolus claremontus Chamberlin, Proc. Biol. Soc. Washington **31**: 165. 1918.

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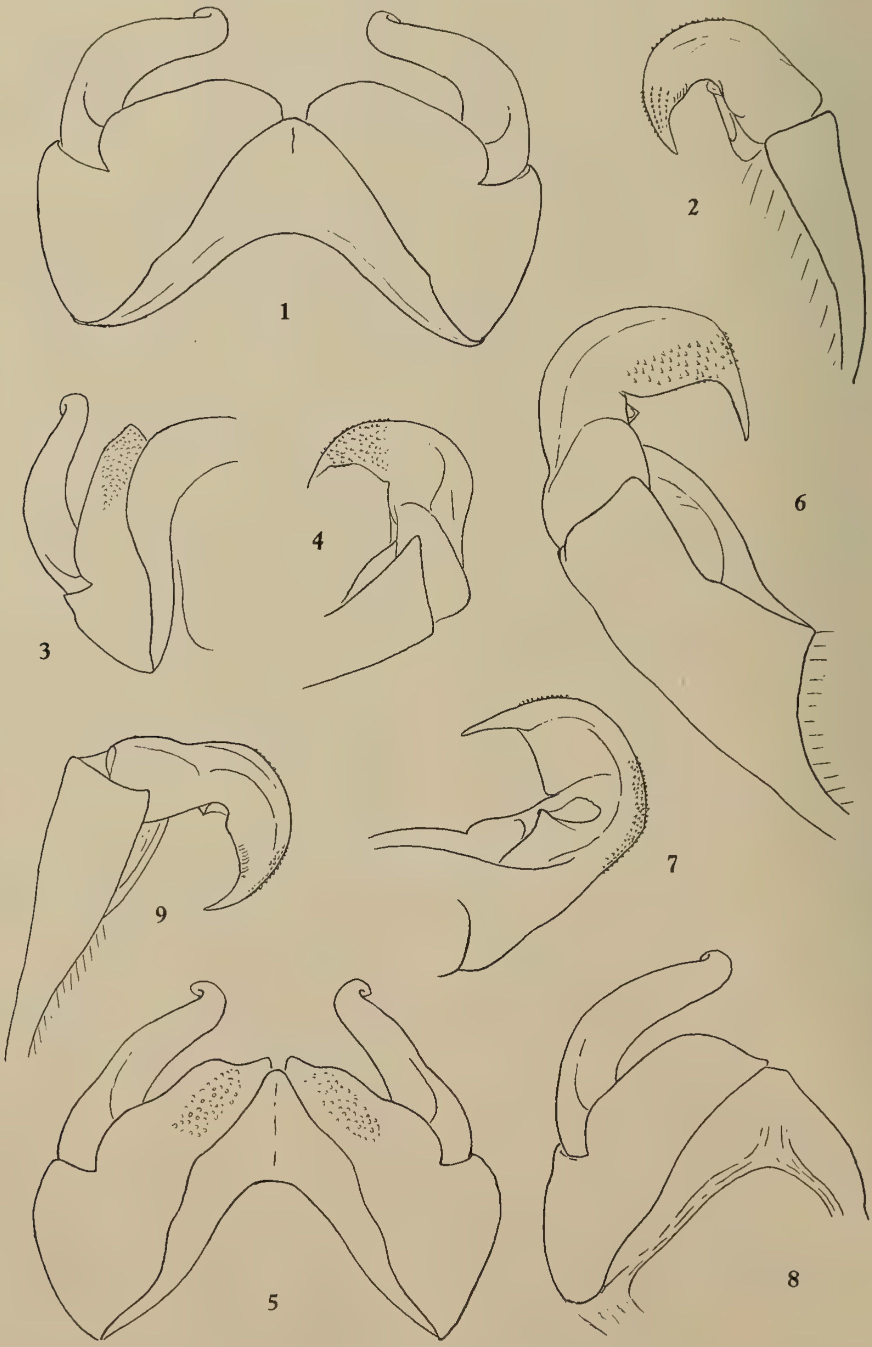
[1] Received January 18, 1949.

[2] In the references given in this paper under the various species, an asterisk (*) preceding a number designates a figure.

Type locality.—California: Claremont.

A common species in Los Angeles County. Figures of the anterior and posterior gonopods are here given (Figs. 1, 2).



FIGS. 1–9.—1, *Auxobolus claremontus* (Chamberlin), anterior gonopods; 2, the same, right posterior gonopod, cephalic aspect; 3, *Auxobolus discipulus*, n. sp., anterior gonopods; 4, the same, right posterior gonopod, cephalic aspect; 5, *Auxobolus ergus*, n. sp., anterior gonopods; 6, the same, right posterior gonopod, cephalic aspect; 7, the same, right posterior gonopod, caudal aspect; 8, *Auxobolus friantus*, n. sp., anterior gonopods; 9, the same, left posterior gonopod, cephalic aspect.

Auxobolus discipulus, n. sp.

Figs. 3, 4

General background of body brown to more or less chestnut, darkened with dusky or black annuli, which embrace a variable proportion of the tergites. Legs brown.

An obviously smaller form than *ergus* and *friantus*, with which it agrees in the more general structural features. Separable from those species in having the distal margin of the anterior sternite of the gonopods widely rounded instead of more or less acuminate. The telopodite of the posterior gonopods has the characteristic form represented in Fig. 4. For anterior gonopods see Fig. 3.

Number of segments, 50–52.

Diameter of male, 5.5–6 mm; of female up to 6.5 mm.

Type locality.—California: Ione. Male and female, March 27, 1941, taken by S. and D. Mulaik.

Other record.—California: Vicinity of Stanford University. Autumn of 1921, collected by J. C. Chamberlin.

Auxobolus friantus, n. sp.

Figs. 8, 9

The general color of the body seems to have been chestnut, now faded from long preservation and probable drying at some time.

The female is smaller than that of *ergus*, but the male is of approximately the same size. It is most readily distinguished by differences in the gonopods. The characteristic form of the posterior gonopods is shown in Fig. 9. The difference in the form of the anterior sternite and the anterior gonopods will be evident on comparing Fig. 8 with the corresponding figure for *ergus*, Fig. 5.

Number of segments, 53–55.

Width of male, up to 8 mm; of female, up to 8.25 mm.

Type locality.—California: Fresno County, Friant. Males and females taken in March 1913 by R. V. Chamberlin.

Auxobolus monachus, n. sp.

Figs. 10, 11

Caudal borders of tergites chestnut; elsewhere more or less blackish, the black in part, especially just above the level of the pores, forming a network of lines. Legs light chestnut.

Clypeal foveolae 4—4.

Most readily identifiable by the form of the telopodite of the posterior gonopods as shown in Fig. 11. The anterior sternite of the anterior gonopods is also of a form different from that of the other known species and is shown in Fig. 10.

Number of segments, 48.

Diameter of male holotype, 7 mm.

Type locality.—California: Monterey County, Hastings Reservation. Male holotype taken March 17, 1940, by Dr. J. M. Linsdale.

Auxobolus simulatus, n. sp.

Figs. 12, 13

A lighter-colored form than the others here listed, the metazonites being chestnut behind the segmental sulcus and light brown to yellow in front of it. The legs are reddish yellow.

Clypeal foveolae 5—5.

The sternite of the anterior gonopods distally acutely pointed, and the coxites of the anterior gonopods distally rounded and rather widely separated from each other as shown in Fig. 12.

Number of segments, 49.

Diameter of male holotype, 7 mm.

Type locality.—California: Riverside. An adult male and a younger specimen were taken in November 1925 by J. C. Chamberlin.

Auxobolus stebbinsi (Chamberlin)

Tylobolus stebbinsi Chamberlin, Proc. Biol. Soc. Washington **57**: 112; *4, 5. 1944.

Type locality.—California: Santa Monica Mountains, Meadow Canyon.

Genus **Californibolus** Verhoeff

Generotype: *Californibolus michelbacheri* Verhoeff.

This genus agrees with *Tylobolus* sens. str. in having the coxal plates of the anterior gonopods broadly in contact distad of the sternite, but differs in the form of the telopodite, which is more laminate and is distally straight and simply concave behind, not strongly curved or subuncate as it is in the other genus. Also the posterior gonopod does not present an obvious second distal lobe present in *Tylobolus*.

Six species, including three given as new, are referred to this genus and are listed below.

Californibolus michelbacheri Verhoeff

Californibolus michelbacheri Verhoeff, Bull. Southern California Acad. Sci. **43**: 50; ***12**: 1, 2, 3. 1944.

Type locality.—California: Vicinity of Fort Seward.

Californibolus oregonus, n. sp.

Figs. 14, 15

The tergites in front of each segmental suture are yellowish, in part slightly reddish brown above, being on most segments dusky along and in front of the suture down the sides, with an annulus of more or less chestnut color behind the suture.

This species, like *pontis* and *rectus,* is smaller than the generotype. In the telopodite of the posterior gonopods the terminal spine, while similarly long, is proportionately thicker at base and more acuminate than in *michelbacheri,* and the general form of the telopodite is different both in the tibiotarsal and the femuroidal divisions. The sternite of the anterior gonopods is distally more acute than in the generotype and presents a furrow or notch at its distal end. See further Figs. 14 and 15.

Number of segments, 51.

Width, 5.2 mm.

Type locality.—Oregon: Springfield. One male taken October 29, 1927, by D. T. Jones.

Californibolus pontis, n. sp.

Figs. 18, 19

Body light brown, with chestnut annuli encircling caudal borders of tergites. Legs light brown.

A considerably smaller form than the generotype and composed of fewer segments. The telopodite of the posterior gonopods differs obviously in the shorter, more rapidly acuminate, terminal spine, in presenting an obtuse angle or tooth on the caudal margin of tibiotarsus, and in general form as shown in Fig. 19. While the anterior gonopods are of the same general form, the sternite differs in presenting an acute tooth or process at the distal end in being more strongly narrowed distad. See further Figs. 18 and 19.

Number of segments, 48.

Length, about 45 mm; width, 4.7 mm.

Type locality.—California: Bridgeville. Male holotype taken in March 1928 by J. C. Chamberlin.

Californibolus rectus, n. sp.

Figs. 16, 17

Brown, with pronounced black annuli back of the segmental sutures and also a black stripe in front of each suture running from above level of pore and narrowing downward. Legs dusky brown, the proximal joints darkest.

The sternite of the anterior gonopods in outline acutely narrowing distad but very narrowly rounded at apex as shown in Fig. 16. Coxites of anterior gonopods of the same general form as in the other species but the telopodite differing at distal end as shown in the figure. The terminal spine of the posterior gonopods is slender, as in *michelbacheri,* but it is proportionately shorter, while there is a characteristic incision or notch on the mesal side where tibiotarsus meets the femuroidal division not present in other species. See further Fig. 17.

Diameter of holotype, 6 mm.

Type locality.—California: Solano County. One male from which the caudal end is lost.

Californibolus uncigerus (Wood)

Spirobolus uncigerus Wood, 1864, Proc. Acad. Nat. Sci. Philadelphia 1864: 15.—Trans. Amer. Phil. Soc. **13:** 209; *36. 1865.

Tylobolus uncigerus (Wood) Cook, Harriman Alaska Exped. **8** (1): 67. 1904.

Type locality.—California.

Wood's figure for this species shows the distinctive features of the genus very well. I have not recognized his species in material so far seen.

Californibolus utahensis (Chamberlin)

Tylobolus utahensis Chamberlin, Pan-Pacific Ent. **2** (2): 60. 1925.

Type locality.—Utah: Zion National Park.

Genus **Hiltonius** Chamberlin

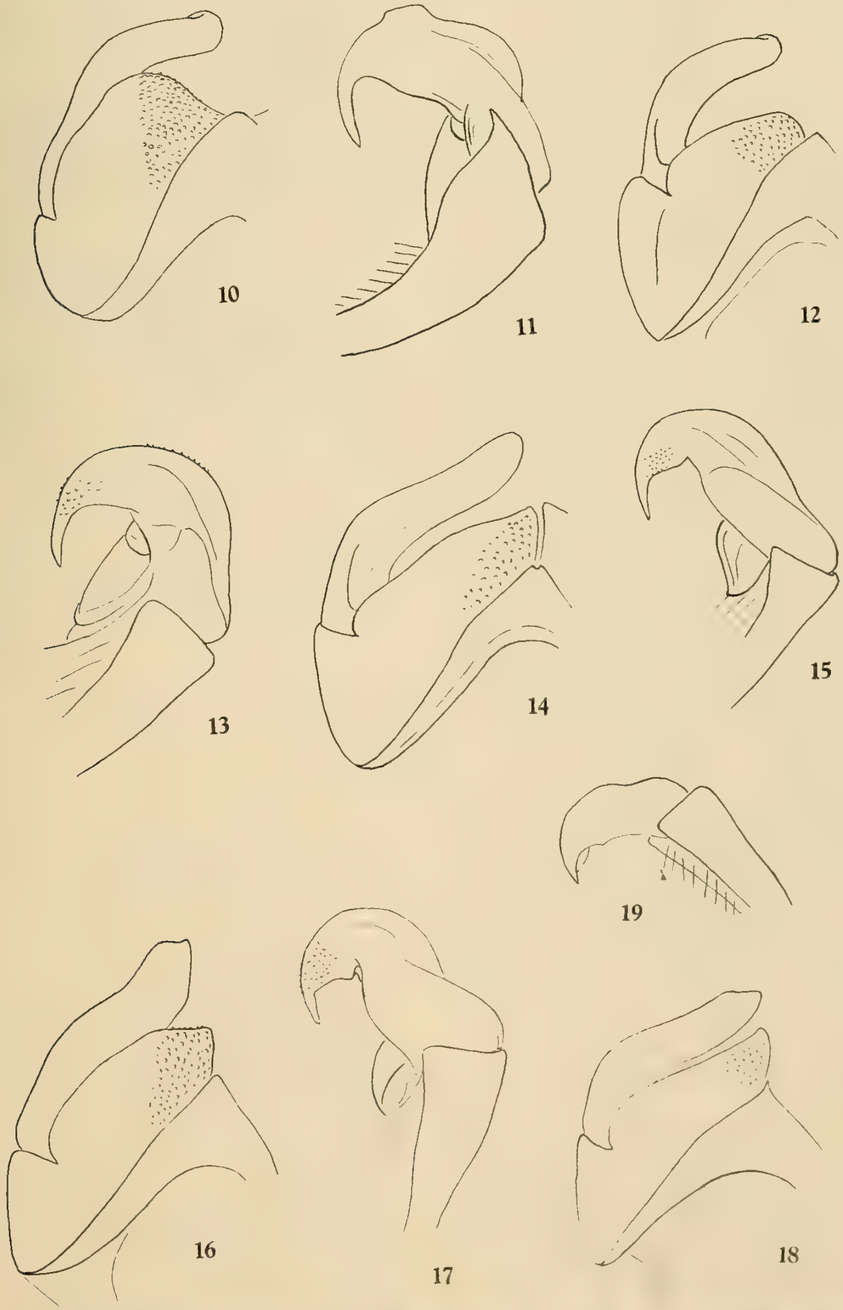
Orthotype: *Hiltonius pulchrus* Chamberlin.

This well-marked genus is represented in California by *H. balboanus*, *H. congregans*, *H. conservatus*, *H. mimus, and H. pius*, in Arizona by *H. thebanus*, and in Mexico by *H. carpinus*, *H. crassus*, *H. erythrotypus*, *H. federalis*, *H. michoacanus*, *H. tancitarus*, and *H. veracruzanus*, all named by the author, and *H. hebes* (Bollman).

Genus **Tylobolus** Cook

Orthotype: *Tylobolus deses* Cook.

Differing from the other genera of the family in the form of the posterior gonopods. These have the general form and structure of those of *Auxobolus* but differ in the much greater length of the terminal spine and in the better-developed setae or prickles that extend to its tip, or very nearly so, instead of their being present only at and proximad of the base of the spine, and also especially in presenting a conspicuous lamina or lobe ectad of the base of the spine. It agrees with *Californibolus* and differs from *Auxobolus* in having the coxites of the anterior gonopods



Figs. 10–19.—10, *Auxobolus monachus*, n. sp., anterior gonopods; 11, the same, right posterior gonopod, cephalic aspect; 12, *Auxobolus simulatus*, n. sp., anterior gonopods; 13, the same, right posterior gonopod, cephalic aspect; 14, *Californibolus oregonus*, n. sp., anterior gonopods; 15, the same, right posterior gonopod, cephalic aspect; 16, *Californibolus rectus*, n. sp., anterior gonopods; 17, the same, right posterior gonopods, cephalic aspect; 18, *Californibolus pontis*, n. sp., anterior gonopods; 19, the same, right posterior gonopods, cephalic aspect.

broadly in contact distad and caudad of the sternite.

Only the type species is at present known with certainty to belong to *Tylobolus* as here restricted.

Tylobolus deses Cook

Tylobolus deses Cook, Harriman Alaska Exped. **8** (1): 65; *4: 3a–3h. 1904.

Type locality.—California: Exact locality not known, but probably either the vicinity of Stanford University or of Claremont.

Family Atopetholidae

Atopetholidae Chamberlin, Proc. Biol. Soc. Washington **31**: 167. 1918.
Onychelidae Verhoeff, Zool. Anz. **122** (11–12): 273. 1938.

The millipeds of this family are in general mostly smaller than those of the Spirobolidae. Superficially they are characterized by having the lower ends of the collum acute and not exceeded below by the second tergite. The gonopods of the male are not articulated to a strongly developed basal support such as present in all members of the Spirobolidae but are characterized by having a separate basal segment set off by a definite suture or joint, this basal article tending to be placed transversely, i.e., to run mesad from the base of the telopodite

The genera now recognized as belonging to this family are *Anelus* Cook, *Atopetholus** Chamberlin, Eurelus Cook, *Gosichelus**, new, *Hesperolus** Chamberlin, *Onychelus** Cook, *Tidolus**, new, and *Watichelus**, new, of our own country, and the genera *Toltecolus* Chamberlin and *Tarascolus* Chamberlin of Mexico. The genera marked with asterisks occur in California and are further noted below.

Genus **Atopetholus** Chamberlin

Orthotype: *Atopetholus californicus* Chamberlin.

Five species have heretofore been described by the author under this genus: *A. angelus*, *A. californicus*, *A. carmelitus*, *A. fraternus*, and *A. paroicus*. A sixth species is here described as new. All six species are from California.

Atopetholus barbaranus, n. sp.

Tergites chestnut to black behind sulcus, in front of which brownish gray to darker brown. Legs from light chestnut to nearly black.

Clypeal foveolae 5—5.

Claws of first three pairs of legs longer than the ultimate joint. The coxae of these legs with swellings or pads beneath, while the coxae of the immediately following pairs are strongly compressed. Sternite of the third gonopod with the usual process.

The species may be readily distinguished from the others thus far known in having the distal end of the posterior gonopods with its border straight, not rolled in or recurved. The two fingers of the anterior gonopods are characteristically long, slender and divergent. The coxites of the anterior gonopods moderately extending beyond the sternite.

Number of segments, 48.

Length of male holotype, 40 mm; width, 5 mm.

Type locality.—California: Santa Barbara County at Orcutt. Several males and females.

Gosichelus, n. gen.

Closely related to *Atopetholus* but differing in the longer, distally narrower or more acuminate sternite of the anterior gonopods and in having the telopodite of the posterior gonopods simply incised or dentate at the tip, not strongly hooked as in the other genus.

Orthotype: *Gosichelus medolus* (Chamberlin).

Two species are at present known for this genus.

Gosichelus jaegeri (Chamberlin)

Onychelus jaegeri Chamberlin, Proc. Acad. Nat. Sci. Philadelphia **99**: 50; *54, 55. 1947.

Type locality.—California: Riverside County, Colorado Desert.

Gosichelus medolus (Chamberlin)

Onychelus medolus Chamberlin, Bull. Univ. Utah, biol. ser., **6** (4); 13; *2: 17, 18. 1941.

Type locality.—Arizona: Olberg.

Genus **Hesperolus** Chamberlin

Orthotype: *Hesperolus wheelleri* Chamberlin. A monotypic genus.

Hesperolus wheeleri Chamberlin

Hesperolus wheeleri Chamberlin, Proc. Biol. Soc. Washington **31**: 170. 1918.

Type locality.—California: Santa Ynez Canyon, Cold Spring Canyon.

Genus **Onychelus** Cook

Orthotype: *Onychelus obustus* Cook.

This genus, characterized by having the telopodite of the posterior gonopods in the form of a simple erect or falcate blade, embraces the following species: *O. michelbacheri* Verhoeff, *O. obustus* Cook, and *O. phanus* Chamberlin from the southwestern area in addition to *O. nigrescens* Chamberlin from Lower California.

Tidolus, n. gen.

Differing from *Atopetholus* in the smaller and simpler telopodite of the anterior gonopods, which does not present a caudally directed branch or process and which is concealed in front view by the coxite. Posterior gonopods comparatively large, each in the form of an elongate, curved or bent, lamina that gradually narrows distad and has its margins turned up so as to form a furrow or channel along mesocaudal side.

Orthotype: *Tidolus parvus* (Chamberlin).

This genus is, so far, monotypic.

Tidolus parvus (Chamberlin)

Atopetholus parvus Chamberlin, Proc. Biol. Soc. Washington **31**: 168. 1918.

Type locality.—California: Claremont.

Watichelus, n. gen.

Differing from *Onychelus* in the much shorter, proportionately broader, sternite of the anterior gonopods, the large telopodite of which lacks the distal prolongation characterizing the other genus. In place of the simple blade representing the telopodite of the posterior gonopods in *Onychelus*, the telopodite in the present genus is distally furcate, with the principal branch simply dentate at its tip.

Orthotype: *Watichelus smithi* (Chamberlin).

This genus is as yet represented by a single species.

Watichelus smithi (Chamberlin)

Onychelus smithi Chamberlin, Proc. Acad. Nat. Sci. Philadelphia **99**: 49; *52, 53. 1947.

Type locality.—California: Riverside County, Murray Canyon, about 3 miles north of Palm Canyon.

ICHTHYOLOGY.—*Keys to the genera of echelid eels and the species of* Muraenichthys *of the Pacific, with two new species.*[1] LEONARD P. SCHULTZ and LOREN P. WOODS,[2] U. S. National Museum.

The worm eels referred to the family Echelidae form a complex group of species, occurring in most of the warm seas of the world. They are difficult to identify, and some species appear to be allied to the Ophichthyidae but lack the sharp-pointed tail. No less than 22 genera have been placed in the family at various times. Among these the following have been assigned to other families: *Verma* Jordan and Evermann, 1896, apparently related to the Ophichthyidae; *Bathymyrus* Alcock, 1890, referred to the Congridae by Myers and Storey, 1939, who refer *Sinomyrus* Lin, 1933, to the Dyssomidae; *Merinthichthys* Rivero, 1934, which may belong to the Moringuidae; *Heteromyrus* Pietschmann, 1935, redescribed in 1938 by him and probably belonging with the Muraenidae; *Chrinorhinus* Rivero, 1932, probably belonging in the family Moringuidae, judged from notes on the type, kindly furnished by William C. Schroeder, of the Museum of Comparative Zoology. This leaves 16 genera, and there have been few attempts to compare them. Parr (Bull. Bingham Oceanogr. Coll. **3** (4): 8. 1927) clearly demonstrated the advisability of referring *Ahlia* to the synonymy of *Myrophis*. After examining the position of dorsal fin anywhere from over rear of head to a little behind anus and the variability of the dentition, we have gone still further

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received January 31, 1949. The drawings were made by Dorothea B. Schultz.

[2] We wish to correct a printer's error in our last paper, "A New Name for *Synchiropus altivelis* Regan, with a Key to the Genera of the Fish Family Callionymidae," in this JOURNAL **38** (12): 420. 1948. Section *5b* in the key is out of place as printed. It should have been placed before section *8a*.

TABLE 1.—MEASUREMENTS MADE ON CERTAIN SPECIES OF MURAENICHTHYS RECORDED IN THOUSANDTHS OF THE TOTAL LENGTH

Characters	*retropinnis* Fowler				*philippinensis*, n. sp.		*johnstonensis*, n. sp.		
	Holotype	Marshall Islands			Philippines		Johnston Island		Bikini Atoll
Total length in mm	114	111	107	105	119	92	145	81	122
Snout to anus	368	378	420	382	520	533	390	365	369
Snout to dorsal origin	544	558	560	518	739	696	569	558	549
Snout tip to tip of chin	7	7	6	7	2	2	8	11	8
Greatest depth	22	19	19	19	27	27	39	42	33
Head	100	105	107	100	98	101	117	126	100
Snout	18	18	19	17	13	13	23	28	19
Eye	6	5	7	5	4	4	10	10	7
Snout to rictus	32	27	28	27	27	26	32	38	30
Anal origin to dorsal origin between vertical lines	158	153	127	128	183	163	169	170	140
Interorbital space	9	8	10	9	10	10	14	13	10

and referred four other genera to *Myrophis* (see key). Myers and Storey (1939, p. 159) did not fully agree with this viewpoint; instead they described a new genus, *Hesperomyrus*. It is our opinion that the recognition of echelid genera must be done on a world basis and not on a study of local fauna.

The numerous species centering around *Muraenichthys* Bleeker are all without pectoral fins, and these too have the position of the dorsal fin origin anywhere from over the rear of the head to $1\frac{4}{5}$ head lengths behind the anus. Since there is much variability in the origin of the dorsal among the various species, in our opinion that character can not be used generically with this group of species. The teeth are variable, differing on jaws and vomer, from bands to a uniserial row, or absent on the vomer. We believe the dentition to be an excellent specific character. We have concluded that *Muraenichthys* should include all those echelid eels without pectoral fins, as defined in our key to genera, with a list of synonyms. Myers and Wade (1941) did not agree with this viewpoint; instead they recognized *Garmanichthys* Seale and described as new *Leptenchelys*, basing their generic separation largely on pointed snout, position of dorsal origin, uniserial vomerine teeth, and short tail, all of which characters are highly variable among the known species of this group. The median groove on underside of snout is a character present in *Leiuranus* of the family Ophichthyidae.

The genus *Muraenichthys* as recognized herein might be broken into subgenera after a comparison of all species in regard to the following important characters: (1) Position of posterior nasal opening, (2) Median groove on underside of snout between nostrils, as in *M. labialis* Seale and *M. vermiformis* (Myers and Wade), (3) pointed or blunt snout, (4) position of anus, and, one of the most important, (5) the dentition. Other characters are origin of dorsal fin, incompleteness of lateral line, position of bases of anterior nostrils in reference to tip of lower jaw, and distance between bases of anterior nostrils.

KEY TO THE GENERA OF ECHELIDAE

1*a*. Vomerine teeth arranged in 2 uniserial rows widely separated except where they divide anteriorly or may meet again posteriorly; teeth in lower jaw in 2 or 3 rows anteriorly, sometimes becoming uniserial posteriorly.

  2*a*. Pectoral fin absent; lip at side of lower jaw folded downward; posterior nasal opening on inside of upper lip, below front of eye, without valvular flap; dorsal origin about $\frac{1}{4}$ to $\frac{1}{3}$ head length behind gill opening; snout and tip of lower jaw broadly rounded; maxillary teeth uniserial. *Chilorhinus* Lütken[3]

  2*b*. Pectoral fin present; lips without folds; posterior nasal opening in upper lip under front of eye with valvular flap; dorsal fin origin slightly behind gill opening; snout and tip of lower jaw bluntly rounded. *Kaupichthys* Schultz[4]

1*b*. Vomerine teeth, if present, arranged along midline of roof of mouth, represented as a single tooth or a uniserial row or a narrow to broad band.

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[3] *Chilorhinus* Lütken, Vid. Med. Nat. Fören. Kjøbenhavn, 1852, **1**: 16. (Type, *C. suensonii* Lütken.)

[4] *Kaupichthys* Schultz, U. S. Nat. Mus. Bull. **180**: 50. 1943. (Type, *K. diodontus* Schultz.)

3*a*. Pectoral fin present, sometimes represented by a tiny dermal flap near upper edge of gill opening.

4*a*. Vomerine teeth in a broad band, notably wider near middle of length than at ends; maxillary and dentary with teeth in a band; dorsal fin origin over tips of pectorals or nearly so; a transverse white line on nape....*Echelus* Rafinesque[5]

4*b*. Vomerine teeth, if present, in a narrow straight band or uniserial, never broadened near middle of length; teeth in jaws usually in 2 or 3 rows anteriorly, sometimes becoming uniserial posteriorly or uniserial throughout their length; dorsal fin origin from over gill opening to slightly behind anus.
Myrophis Lütken[6]

3*b*. Pectoral fin absent; dorsal origin from over middle of head to any location as far posteriorly as $1\frac{4}{5}$ head lengths behind a vertical line through anus; teeth on vomer, if present, varying from a uniserial row to a band and those on jaws varying from a uniserial row to a band..*Muraenichthys* Bleeker

Genus **Muraenichthys** Bleeker

Muraenichthys Bleeker, Nat. Tijdschr. Ned. Ind. **4**:505. 1853; Verh. Batav. Genoot. **25**, Muraen.: 52, 64, 71. (Type, *Muraena gymnopterus* Bleeker, designated in Atlas Ichthy.: 20. 1864.)

Scolecenchelys Ogilby, Proc. Linn. Soc. New South Wales, 1897 (2): 246. (Type, *Muraenichthys australis* Macleay.)

Myropterus Ogilby, Proc. Linn. Soc. New South Wales, 1897 (2): 247. (Type, *M. laticaudata* Ogilby (not of Bleeker).)

Garmanichthys Seale, Bull. Mus. Comp. Zool. **61** (4): 80. 1917. (Type, *G. dentatus* Seale.)

Arenichthys Beebe and Tee-Van, Zoologica **23** (3): 301. 1938. (Type, *A. apterus* Beebe and Tee-Van.)

Leptenchelys Myers and Wade, Allan Hancock Pacific Exped. **9** (4): 72. 1941. (Type, *L. vermiformis* Myers and Wade.)

During our studies of the fishes of the atom bomb tests from the Marshall Islands and vicinity, we have observed two new species of *Muraenichthys*, one from the Philippines and the other from Johnston Island south of the Hawaiian group. These two new echelid eels are distinguished in the following key and then more fully described.

TENTATIVE KEY TO THE SPECIES OF MURAENICHTHYS OF INDO-PACIFIC

1*a*. Dorsal fin origin more than one head length behind anus; snout not strongly acute.

2*a*. No teeth on premaxillary or vomer; snout to anus 2.4 to 2.7, snout to dorsal origin 1.8 to 1.9, all in total length.

3*a*. Greatest depth 45 to 54 and head 10 to 10.5, all in total length.
Muraenichthys retropinnis Fowler

3*b*. Greatest depth 24 or 25, head 7.9 to 8.5 all in total length.
Muraenichthys johnstonensis, n. sp.

2*b*. Teeth on vomer biserial, those on maxillary and on dentary uniserial, a few premaxillary teeth; posterior nasal opening on outside of upper lip below lower front of eye; greatest depth 37, head 9.9 to 10.2, snout to dorsal origin 1.4, all in total length.
Muraenichthys philippinensis, n. sp.

1*b*. Dorsal fin origin less than a head length behind anus or in advance of it; teeth present on maxillary and on vomer.

4*a*. Dorsal fin origin closer to gill opening than to anus (see also 4*b*, 4*c*, 4*d*).

5*a*. Dorsal fin origin over gill opening or in front of it.

6*a*. Dorsal origin over gill opening; teeth in a narrow band on maxillary and dentary, inner row largest; vomerine teeth biserial.
Muraenichthys bicollaris Myers and Wade

6*b*. Dorsal origin notably in advance of gill openings; teeth uniserial on maxillary, dentary and vomer.
Muraenichthys vermiformis Myers and Wade

5*b*. Dorsal fin origin somewhat behind gill opening.

7*a*. Anterior nostrils tubular, elongate, their bases in front of tip of chin, and separated by a groove, sides of which are formed by a dermal fold, the groove continuing on underside of snout nearly to its tip; dorsal fin origin nearly a head length behind gill opening; teeth in a single row on maxillary and on dentary; rear margin of eye over rictus; snout acute.

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[5] *Echelus* Rafinesque, Caratteri Nuov. An. Sicil.: 63. 1810. (Type, *E. punctatus* Rafinesque, designated by Bleeker, Atlas Ichthy. **4**: 20. 1864.)

Myrus Kaup, Archiv Naturg. 1856 (1): 53. (Type, *Muraena myrus* Linnaeus = *E. punctatus* Rafinesque.)

[6] *Myrophis* Lütken, Vid. Medd. Nat. Fören. Kjøbenhavn, 1852, **1**: 1. (Type, *Myrophis longicollis* Kaup = *Myrophis punctatus* Kaup.)

Paramyrus Günther, Catalogue of fishes in the British Museum **8**: 51. 1870. (Type, *Conger cylindroideus* Ranzani, designated by Jordan and Davis, Rep. U. S. Fish Comm. **16**: 641. 1892.)

Holopterua Cope, Trans. Amer. Philos. Soc. **16**: 482. 1871. (Type, *H. plumbea* Cope.)

Ahlia Jordan and Davis, Rep. U. S. Fish Comm. **16**: 641. 1892. (Type, *Myrophis egmontis* Jordan.)

Parabathymyrus Kamohara, On the offshore bottom-fishes of Prov. Tosa, Shikoku, Japan: 14, fig. 4. 1938. (Type, *P. macrophthalmus* Kamohara.)

Hesperomyrus Myers and Storey, Stanford Ichthy. Bull. **1** (4): 156. 1939. (Type, *H. fryi* Myers and Storey.)

Muraenichthys labialis Seale

7*b*. Anterior nostrils tubular, not notably elongate, their bases opposite tip of chin; no groove or dermal folds between anterior nostrils; teeth on maxillary and on dentary in a narrow band, inner row largest; vomerine teeth in 2 rows or an irregular row.

8*a*. Dorsal fin origin less than a snout length behind gill openings.

Muraenichthys apterus (Beebe and Tee-Van)

8*b*. Dorsal fin origin about 4 or 5 snout lengths behind gill openings.

Muraenichthys macropterus Bleeker[7]

4*b*. Dorsal fin origin equidistant or nearly so between gill opening and anus.

Muraenichthys thompsoni Jordan and Richardson[8]

4*c*. Dorsal fin origin closer to anus than gill opening, but notably in front of anus; tip of snout and of lower jaw bluntly rounded.

9*a*. Teeth on vomer in a broad flattish patch forward, becoming a row posteriorly; those on maxillary and on dentary in a band.

10*a*. Dorsal fin origin $\frac{1}{5}$ to $\frac{1}{2}$ head length in front of anus.

Muraenichthys hattae Jordan and Snyder

10*b*. Dorsal fin origin $\frac{2}{3}$ to $\frac{4}{5}$ head length before anus.

Muraenichthys gymnopterus (Bleeker)[9]

9*b*. Teeth on vomer in one or two rows; teeth on maxillary and on dentary uniserial or biserial.

11*a*. Dorsal fin origin $\frac{2}{3}$ to $\frac{4}{5}$ head length in front of anus.

Muraenichthys godeffroyi Regan[10]

11*b*. Dorsal origin from $\frac{1}{5}$ to $\frac{1}{2}$ head length in front of anus.

12*a*. Vomerine teeth biserial.

Muraenichthys sibogae Weber and de Beaufort

12*b*. Vomerine teeth uniserial.

Muraenichthys cookei Fowler

4*d*. Dorsal fin origin over anus or nearly so to less than a head length behind anus.

13*a*. Rear margin of eye notably in advance of rictus of mouth.

14*a*. Teeth on maxillary and on dentary uniserial, those on vomer in 1 or 2 rows; snout acute.

15*a*. Dorsal origin $\frac{3}{4}$ head length behind anus; greatest depth 40 to 45 in total length.

Muraenichthys tasmaniensis McCulloch

15*b*. Dorsal fin origin about $\frac{1}{5}$ head length behind anus.

Muraenichthys iredalei Whitley

15*c*. Dorsal fin origin over anus or anal origin or nearly so.

16*a*. Greatest depth 27 to 30 in total length.

Muraenichthys macrostomus Bleeker

16*b*. Greatest depth 40 to 50 in total length.

Muraenichthys australis Macleay[11]

14*b*. Teeth on maxillary and on dentary in at least two rows or in a narrow to wide band, sometimes becoming one row posteriorly; dorsal origin from nearly over anus to $\frac{1}{2}$ head length behind anus.

17*a*. Snout bluntly rounded; bases of anterior nostrils a little behind tip of chin; greatest depth 20 to 30 in total length, teeth in broad bands on maxillary, dentary and on vomer.

Muraenichthys schultzei Bleeker

17*b*. Snout acute; greatest depth 30 to 50 in total length.

18*a*. Rear margin of eye only slightly in advance of rictus of mouth; tip of snout to rictus about 4 in head; bases of anterior nostrils opposite tip of chin; teeth on inner row of maxillary and dentary largest; eye diameter about equal to distance from tip of chin to tip of snout; anterior margin of eye closer to rictus than tip of chin; snout moderately pointed; eye 12 to 15 in head.

Muraenichthys gymnotus Bleeker

18*b*. Rear margin of eye notably in advance of rictus; tip of snout to rictus about 3 in head; eye a little in front of middle of cleft of mouth; snout much pointed; eye 26 to 27 times in head.

Muraenichthys acutirostris Weber and De Beaufort

13*b*. Rear margin of eye over rictus of mouth; dorsal fin origin from slightly in front of anus to $\frac{1}{2}$ head length behind anus; snout bluntly rounded; greatest depth about 24 to 34 in total length.

Muraenichthys laticaudata (Ogilby)

Muraenichthys johnstonensis, n. sp.

Fig. 1

Holotype.—U.S.N.M. no. 141268, Johnston Island, northern reef, August 28–29, 1947, L. P. Schultz, total length 145 mm.

Paratypes.—U.S.N.M. no. 141269, taken with holotype and bearing same data, total length 81

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[7] Synonym: *Muraenichthys breviceps* Günther, Ann. Mag. Nat. Hist., ser. 4, **17**: 401. 1876 (Tasmania).

[8] Probable synonym: *Muraenichthys malabonensis* Herre, 1923.

[9] Synonym: *M. microstonus* Bleeker, Atlas Ichthy.: 32, pl. 150, fig. 2. 1864 (Celebes Sea).

[10] Synonym: *Muraenichthys elerae* Fowler, 1934, U.S.N.M. no. 92348, holotype.

[11] Probable synonym: *M. oliveri* Waite, 1910.

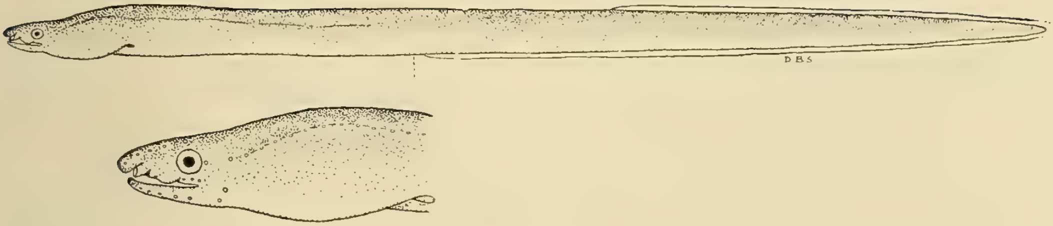

Fig. 1.—*Muraenichthys johnstonensis*, n. sp.: Holotype (U.S.N.M. no. 141268), from Johnston Island; total length 145 mm.

mm; U.S.N.M. no. 141692, Bikini Atoll, Arji Island, lagoon, depth 20 to 40 feet, August 7, 1946, Brock and Herald, 1 specimen, 122 mm.

Description.—Precision measurements were made on the types and these data are recorded in thousandths of the total length in table 1.

Greatest depth 24 or 25, head 7.9 to 8.5, snout to anus 2.6 to 2.7, snout to dorsal fin origin 1.8, all in the total length. Greatest depth 3.0, snout tip to tip of chin 11 to 15, eye 11 to 13, snout 4.4 to 5.0, interorbital space 8.5 to 9.3, snout to rictus 3.3 to 3.7, all in the length of the head.

Posterior nasal opening in upper lip below front of eye with valvular flap, anterior nostrils tubular, their bases opposite tip of chin; no groove on under side of snout between nostrils; eye small, without free margin; dorsal fin origin about 1.3 to 1.5 head lengths behind anus; anal origin close behind anus; both dorsal and anal fins confluent with the small minutely rayed caudal fin; anus a little behind the front third of the total length; gill opening a small pore on lower sides; no pectoral fin; lateral line near middle of sides incomplete, ending a little in front of anus; lips without cirri; tongue adnate to floor of mouth; teeth almost villiform in a band on maxillary, broadening posteriorly opposite eye, those on dentary similar and in a band; no teeth on vomer; teeth either lacking on premaxillary or embedded; rear margin of eye over rictus or slightly behind it, front margin of eye closer to rictus than tip of chin; snout bluntly rounded.

Color in alcohol.—Sides and back finely brown pigmented; ventral side white; area below and behind eye white.

Remarks.—This species is closely related to *M. retropinnis* Fowler in regard to its peculiar dentition, especially the long band of teeth on the maxillary broadened opposite orbit and complete lack of teeth on the vomer. It differs from *retropinnis* in having a robust body of a compressed shape instead of more tubular as in *retropinnis*. From other species of *Muraenichthys* in the Pacific it may be separated by means of the key.

Muraenichthys philippinensis, n, sp.

Fig. 2

Holotype.—U.S.N.M. no. 134951, Philippine Islands, Badian Island, lat. 11°31′40″N., long. 124°42′40″E., *Albatross*, April 14, 1908, 32 fathoms, total length 92 mm.

Paratype.—U.S.N.M. no. 134952, Philippine Islands, Luzón, Balayan Bay, *Albatross*, February 20, 1908, surface light, total length 119 mm., condition poor.

Description.—Precision measurements were made on the types and these data, recorded in table 1, are expressed in thousandths of the total length.

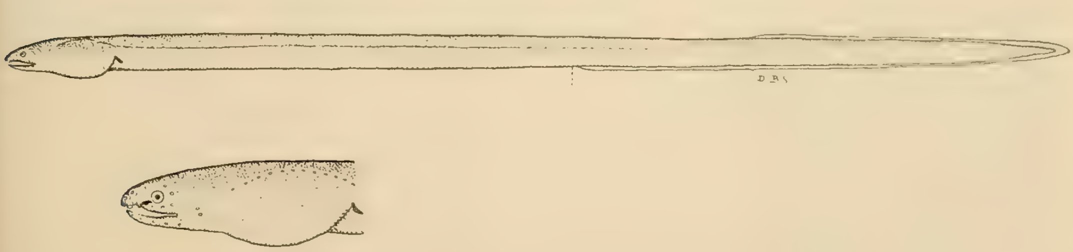

Fig. 2.—*Muraenichthys philippinensis*, n. sp.: Holotype (U.S.N.M. no. 134951), from Badian Island, Philippines; total length 92 mm.

Greatest depth 37, head 9.9 to 10.2; snout to anus 1.9, snout to dorsal origin 1.4, all in the total length. Greatest depth 3.7, snout tip to tip of chin 47 to 58, eye 23, snout 7.7 to 7.8, interorbital space 9.8 to 10.3, snout to rictus 3.7 to 3.9, all in the length of the head.

Posterior nasal opening on outside of upper lip at lower front of eye, with a short valvular flap, anterior nostrils tubular, their bases opposite tip of chin; no groove under tip of snout; eye small, without free margin; dorsal fin origin about $1\frac{2}{3}$ to $1\frac{4}{5}$ head lengths behind anus; anal fin origin close behind anus; both dorsal and anal fins confluent with the small minutely rayed caudal fin; anus farther posteriorly than is usual in echelid eels, only a little in front of the middle of the total length; gill opening a rounded pore on sides; no pectoral fins; lateral line along sides, incomplete, ending a little less than a head length behind anus; lips without cirri; tongue adnate to floor of mouth; teeth short conical, uniserial on maxillary and on dentary, biserial on vomer, and a few teeth on premaxillary far forward, rear margin of eye notably in advance of rictus; anterior margin of eye closer to tip of chin than rictus; snout bluntly pointed.

Color in alcohol.—Plain pale, probably whitish when first preserved.

Remarks.—This new species differs from all other species of *Muraenichthys* of the Pacific in the combination of dorsal origin far behind a vertical line thru anus, posterior nostrils opening on outside of upper lip below front of eye, and the dentition. It may be separated from other species by means of the key.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

425TH MEETING OF BOARD OF MANAGERS

The 425th meeting of the Board of Managers, held in the Cosmos Club, February 14, 1949, was called to order at 8:05 P.M. by the President, F. H. H. Roberts, Jr. Others present were: F. B. Silsbee, H. S. Rappleye, N. R. Smith, H. A. Rehder, Alan Stone, W. W. Diehl, W. N. Fenton, C. L. Gazin, F. D. Rossini, C. F. W. Muesebeck, Alexander Wetmore, W. A. Dayton, R. S. Dill, Margaret Pittman, H. W. Hemple, O. B. French, F. M. Setzler, and, by invitation, Herbert Friedmann, R. W. Brown, J. L. Shereshefsky, and M. A. Mason.

The minutes of the 424th meeting were read and approved.

The following appointments were announced by the President:

Appointed Members of Executive Committee: F. B. Silsbee and N. R. Smith.

Board of Editors of the Journal: Alan Stone was designated Senior Editor. F. J. Hermann was named to replace J. I. Hoffman. J. C. Ewers and J. I. Hoffman were appointed Associate Editors for terms of 3 years representing, respectively, the Anthropological Society of Washington and the Chemical Society of Washington.

Committee on Membership: H. E. McComb (chairman), R. G. Bates, C. A. Betts, Wilbur Burbank, W. W. Diehl, Regina Flannery, C. L. Larson, C. S. Piggot, R. J. Seeger, H. W. Wells, C. E. White.

Committee on Meetings: Herbert Friedmann (chairman), G. A. Cooper, F. M. Defandorf, C. L. Garner, F. B. Scheetz.

Committee on Monographs: To January 1950—R. W. Brown (chairman), H. A. Rehder. To January 1951—W. N. Fenton, E. W. Price. To January 1952—P. H. Oehser, J. R. Swallen.

Committee on Awards for Scientific Achievement: W. A. Dayton (general chairman). *For the Biological Sciences:* W. A. Dayton (chairman), H. P. Barss, Elmer Higgins, B. J. Olson, E. W. Price, T. D. Stewart, J. S. Wade. *For the Engineering Sciences:* H. G. Dorsey (chairman), R. C. Duncan, H. N. Eaton, H. W. Hemple, W. R. Osgood, Walter Ramberg, O. W. Torreson. *For the Physical Sciences:* W. J. Rooney (chairman), N. L. Drake, F. L. Mohler, P. A. Neal, M. X. Sullivan, J. H. Taylor, J. S. Williams.

Committee on Grants-in-Aid for Research: J. L. Shereshefsky (chairman), Anna E. Jenkins, J. M. Cooper.

Committee on Policy and Planning: To January 1950—J. E. Graf (chairman), F. B. Silsbee. To January 1951—A. H. Clark, L. W. Parr. To January 1952—M. A..Mason, J. I. Hoffman.

Committee of Auditors: L. G. Henbest (chairman), N. F. Braaten, C. V. Morton.

Committee of Tellers: N. M. Judd (chairman), P. S. Conger, J. P. E. Morrison.

The following report of the Executive Committee was presented:

The Executive Committee met in the Cosmos Club at 8:00 P.M., on February 9, 1949, to consider the 1949 Academy budget. Present were: F. H. H. Roberts, Jr. (chairman), H. S. Rappleye, F. B. Silsbee, N. R. Smith, and F. M. Setzler. After considerable deliberation, based on the estimated receipts for the year 1949, the Committee unanimously approved the following budget as submitted by the Treasurer and recommended it to the Board of Managers:

	1948[1]	1949 (estimated)
Dues	$3,726.25	$3,600.00
Subscriptions	1,441.62	1,500.00
Interest & dividends	968.50	1,000.00
Sale of publications	176.90	175.00
	$6,313.27	$6,275.00

Proposed allotments for the Academy during 1949 as well as a comparison of expenditures for the year 1948:

	1948[2]	1949 (estimated)
JOURNAL:		
Printing & mailing	$4,950.22	
Illustrations	569.87	
Reprints	646.42[3]	
Total	$6,166.51	
Less charges to authors	913.66[4]	
Total	$5,252.85	$6,303.42[6]
Ed. asst. & misc.	350.00	350.00
Total for JOURNAL	$5,602.85	$6,653.42
Secretary	555.93	550.00[7]
Treasurer	247.01	300.00[8]
Subscrip. Mgr. & C. of Pubs.	77.64[5]	50.00
Meetings Committee	462.98	500.00
Membership Committee	10.51	20.00
Science Calendar	62.10[9]	10.00
Science Fair		100.00
TOTAL	$7,019.02	$8,183.42
An increase of $1,164.40		
Less estimated receipts		6,275.00
Operating deficit for 1949		$1,908.42
Additional obligations due in 1949		
Estimated cost of Monograph No. 1		$2,300.00
Index to JOURNAL—1st payment		500.00
Estimated decrease in net worth		$4,708.42

The Executive Committee also recommended that the Board consider the number of free copies of a monograph that should be given to the author. The Committee suggested that not less than 6 copies and not more than 10 copies be given to the author.

As indicated in the 1949 budgetary item for the office of the Secretary, the Committee unanimously approved the suggestion that in order to save the increase in postage and cost of inserting notices in envelopes, future notices of the Academy monthly meetings be printed on 1-cent postcards (a saving of approximately $106).

The Executive Committee adjourned at 10 P.M.

The Board of Managers approved the Budget for 1949 as recommended by the Executive Committee.

After considerable discussion as to how the Academy might recover the expected decrease in the net worth of the Academy, it was voted to place this matter in the hands of the Committee on Policy and Planning.

The Chairman of the Committee on Monographs recommended that 10 copies of a monograph be given to the author and that the author be permitted to purchase additional copies at a 20 percent discount. This recommendation was adopted by the Board.

The Board approved the use of the penny postcard for the announcements of the Academy meetings.

The Secretary read a communication from Karl F. Herzfeld, past Chairman of the Committee on Awards in the Physical Sciences, in which it was suggested that the present rules be changed from "40th birthday" to "45th birthday." It was voted to refer this matter to the Committee on Policy and Planning.

M. A. Mason, Chairman of the Committee on Encouragment of Science Talent, reviewed the work of the Committee during the past few weeks and recommended (1) that a special certificate of award be prepared to be given to the high-school student or students selected by the Committee; (2) that these awards be given at the regular March meeting of the Academy at which time the Academy presents the Awards for Scientific Achievements; and (3) that the Committee be empowered to select the student winners without prior approval by the Board of Managers. The third item was suggested because of the short space of time between the selection of the winner and the March meeting. The above recommendations were adopted by the Board.

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[1] Includes $120 from delinquent dues—not repeatable in 1949.

[2] These figures not in agreement with annual report, since bills paid since January 1, 1949, on 1948 accounts are included here.

[3] December reprints estimated.

[4] December charges to authors estimated.

[5] This exceeds original allotment because of subscription campaign authorized separately.

[6] 1948 cost plus 20 percent.

[7] Practically unchanged despite increased postage and printing costs because of expected savings resulting from use of post cards for meeting notices.

[8] Increase necessitated by need for considerable printing and some increase in postage costs.

[9] Includes $50 for 1948 and $12.10 for 1947.

Dr. MASON announced that three subcommittees were being created out of the present standing Committee on Encouragement of Science Talent and that the annual Science Fair would be held from April 1 to April 9 in the Auditorium of the Department of Commerce.

The Board recommended that the Committee on the Index of the Journal be reconstituted for 1949.

Three persons nominated for resident membership at the 424th meeting of the Board of Managers were elected.

C. O. APPLEMAN and PAUL BARTSCH were transferred to the retired list of members, effective December 31, 1948, and L. A. ROGERS was transferred to the retired list effective December 31, 1949.

The Secretary reported the following deaths: JOSEPH A. AMBLER, Southern Regional Research Laboratory, U. S. Department of Agriculture, on October 6, 1948 (elected April 10, 1925); and EDWARD R. STITT, Rear Admiral (Retired), Washington, D. C., on November 13, 1948 (honorary member, elected March 5, 1939).

The meeting was adjourned at 9:50 P.M.

426TH MEETING OF BOARD OF MANAGERS

The 426th meeting of the Board of Managers was held in the Cosmos Club on March 14, 1949. The meeting was called to order at 8:03 P.M. by the President, F. H. H. ROBERTS, Jr. Also present were: H. S. RAPPLEYE, N. R. SMITH, ALAN STONE, F. G. BRICKWEDDE, W. W. DIEHL, W. N. FENTON, W. F. FOSHAG, F. D. ROSSINI, J. B. REESIDE, Jr., F. A. WEISS, R. S. DILL, MARGARET PITTMAN, H. W. HEMPLE, H. G. DORSEY, O. B. FRENCH, F. M. SETZLER, and, by invitation, H. E. MCCOMB, H. FRIEDMANN, R. W. BROWN, J. L. SHERESHEFSKY, and M. A. MASON.

The minutes of the 425th meeting were read and approved.

The President announced that he had reconstituted the 1948 Committee on the Index of the Journal, consisting of W. N. FENTON (chairman), J. I. HOFFMAN, M. C. MERRILL, P. H. OEHSER, and H. A. REHDER.

The chairman of the Committee on Membership, H. E. MCCOMB, presented 11 resident and 1 non-resident nominations for membership.

The Committee on Policy and Planning made the following recommendations: (1) That there be no change made in the present age requirement for the Academy Awards; (2) that the publication of the 4-page insert listing officers of the Academy and Affiliated Societies be omitted. The Board unanimously approved the above recommendations.

The Chairman of the Committee on Science Talent, M. A. MASON, presented the following report:

> The Committee on Encouragement of Science Talent has examined the records of the 29 local contestants in the National Science Talent Search conducted by the Westinghouse Educational Foundation and Science Service. The Board of Judges of the national search selected two national winners and two honorable mention contestants from this group. In compliance with our agreement with Science Service as a sponsor we were required to name these four contestants as local winners.
>
> The Committee considered the records of those contestants not selected on a national basis and concluded that three additional local contestants had demonstrated science talent worthy of recognition by the Academy. It is the opinion of the Committee that the number of local winners selected should not establish a precedent, it being felt that the demonstration of science talent worthy of recognition should be the principal criterion of selection.
>
> The Committee, as a result of its study, recommended the following persons to receive the Certificate of Merit of the Academy:
>
> WALTER GILBERT, for science talent demonstrated by his study of the one-step separation of zirconium and hafnium. (3309 Thirty-fifth Street, NW., Washington 16, D. C., age 16, Sidwell Friends School.)
>
> CARL WEBER WERNTZ, for science talent demonstrated by his observation of variable stars. (620 Nicholson Street, NW., Washington 11, D. C., age 17, Calvin Coolidge High School.)
>
> AGNES SCOTT PRESTON, for science talent demonstrated by her studies in chemotherapy. (1523 P Street, NW., Washington 5, D. C., age 17, Dunbar High School.)
>
> JOHN RICHARD MCGONEGAL, for science talent demonstrated by his studies of the applications of radioactive substances in chemistry. (4524 South Dakota Avenue, NE., Washington 17, D. C., age 16, St. Anselm's Priory High School.)
>
> ELLEN MAE MACEWEN, for science talent demonstrated by her experiments in chemiluminescence. (4825 Montgomery Lane, Bethesda 14, Md., age 17, Woodrow Wilson High School.)
>
> CHARLES EDWARD WEIR, for science talent demonstrated by his studies of audio frequency filters. (1206 Kearny Street, NE., Washington, D. C., age 15, Dunbar High School.)
>
> WILLIAM STANTON SHIPLEY, for science talent demonstrated by his experiments with high speed automobile engines. (4311 Brandywine Street, NW., Washington 16, D. C., age 17, Woodrow Wilson High School.)

The Committee further recommended that the Secretary of the Academy be authorized to send a letter of recommendation for each of the above to the college or university of their choice, indicating that they are recipients of the Academy's Certificate of Merit and that they are considered worthy of consideration for scholarship awards by the college or university.

The Board unanimously accepted the recommendations in the above report and offered a vote of thanks to the Committee.

P. L. Ricker, having retired from the gainful practice of his profession, was transferred to the retired list of membership effective December 31, 1948.

The Secretary reported the death of the following members: Stephen R. Capps, U. S. Geological Survey, on January 19, 1949 (elected December 4, 1914); S. H. McCrory, U. S. Department of Agriculture, on February 18, 1949 (elected May 17, 1937); and Bailey Willis, original member, 1898, formerly of the U. S. Geological Survey, on February 19, 1949.

The Senior Editor, Alan Stone, notified the Board that under the new publishing contract with Waverly Press, Inc. the Academy could obtain 100 four-page reprints for $2.48, whereas the previous publishing company charged $2.40 for 50 four-page reprints. Moreover, Waverly Press, Inc., will not furnish less than 100 reprints. On this basis, Dr. Stone recommended that in the future authors of obituaries should be granted 100 reprints instead of the customary 50 reprints. The Board approved this recommendation.

The President read a letter from J. I. Hambleton, Division of Bee Culture, Bureau of Entomology and Plant Quarantine, requesting the Academy to sponsor an illustrated lecture by Dr. Karl von Frisch. Mr. Hambleton indicated that Dr. von Frisch was an excellent speaker and would be willing to give a lecture in Washington. Mr. Hambleton also stated that he would be willing to defray the necessary expenses in bringing Dr. von Frisch to Washington. He had also arranged for the use of the auditorium in the U. S. National Museum for Friday evening, April 15. After some discussion the Board voted to sponsor the von Frisch lecture if it were possible for the chairman of the Meetings Committee to arrange with the speaker scheduled for the regular April meeting of the Academy to present his lecture in May, and that the customary expense be assigned to the April 15 meeting. It was also hoped that one or more of the Affiliated Societies would join with the Academy for the von Frisch lecture.

The President read a communication from the American Documentation Institute. It was recommended that this matter be turned over to the Committee on Policy and Planning.

The meeting was adjourned at 9:45 p.m.

F. M. Setzler, *Secretary.*

ANTHROPOLOGICAL SOCIETY

The Anthropological Society of Washington at its annual meeting on January 18, 1949, elected the following officers; President, W. Montague Cobb; Vice-President, Gordon R. Willey; Secretary, Marshall T. Newman (reelected); Treasurer, Margaret C. Blaker; Councilors to the Board of Managers, E. Wyllys Andrews IV (reelected), Stella L. Deignan (reelected), William H. Gilbert, Jr., Carl F. Miller, Eugene C. Worman, Jr.; Representative to the Washington Academy of Sciences, William N. Fenton.

A report of the membership and activities of the Society since the last annual meeting follows:

Life members, 1; Active members, 71; Associate members, 15; Total, 87. This represents an increase of four since last year.

The members elected during the year were: Active members: Mrs. Margaret C. Blaker, Dr. Cornelius J. Connolly, Dr. Stella L. Deignan, Dr. Edward A. Kennard, D'Arcy McNickle, Carl F. Miller, Bertram L. Pear, Miss LaVerna Pendleton, Mrs. Betty U. Randall, Dr. Henry L. Smith, Jr., Mrs. Marion L. Vanderbilt. *Associate members:* Robert C. Cook, Dr. Lowell H. Hattery, Dr. Robert R. Solenberger.

The Society records its deep sense of loss at the deaths of Frank B. Noyes, a member since 1939, and Dr. Ruth Benedict, a member while in Washington during the war.

The report of the Treasurer follows:

Income:

A.S.W. dues collected	$95.00
Interest, Perpetual Building Association..............	59.11
Dividends, Washington Sanitary Improvement Co....	21.00
Dividends, Washington Sanitary Housing Co....	12.00
Interest, U. S. Savings Bond....................	12.50

Issuance 21 additional shares of capital stock (@ par value $10) by Washington Sanitary Improvement Co.	210.00	
Sale of Old Series *Anthropologists*	47.00	
		$456.61
Expenditures:		
A.A.A. dues paid for Secretary, Treasurer, and 1 life member	15.00	
Expenses, speakers	4.70	
Incidental meeting expenses	41.75	
Printing and mailing notices	48.08	
Authorized from President's contingent fund	10.53	
Miscellaneous expenses, Secretary and Treasurer	16.19	
A.S.W. share, Science Calendar Service	5.00	
Authorized by Board of Managers	25.00	
Dues, Inter-American Society of Anthropology and Geography	3.00	
		169.25
Balance		$287.36
Assets:		
Funds invested in Perpetual Building Association	$2,000.00	
42 shares Washington Sanitary Improvement Co. (par value $10 per share)	420.00	
2 shares Washington Sanitary Housing Co. (par value $100 per share)	200.00	
U. S. Savings Bond, Series G	500.00	
Cash in bank	295.51	
Total as of December 31, 1948		$3,415.51
Total as of December 31, 1947		3,128.15
Increase		$ 287.36
Less Bills outstanding:		
To A.A.A. (Subscription to American Anthropologist) For 1 member, 2 years, 1949–50		10.00
Net increase		$277.36

Except for the program of November 17 at the Cosmos Club, all regular meetings were held at the U. S. National Museum. The programs for the first part of the year were arranged by the Secretary; for the second part of the year, by a program committee comprising Dr. Gordon R. Willey (chairman) and Dr. George M. Foster.

Titles of papers presented before the regular meetings of the Society were:

January 7, 1948, 747th meeting, N. Datta-Majumder, *The dynamics of Santal culture: A study in culture change.*

February 4, 1948, 748th meeting, John Province, *Current trends in Indian affairs.*

March 3, 1948, 749th meeting (in conjunction with 15th James Arthur Annual Lecture on the Sun), Herbert J. Spinden, *Mexican calendars and the solar year* (slides).

April 7, 1948, 750th meeting, Regina Flannery, *A Plains Indian individualist.*

May 5, 1948, 751st meeting, R. M. Tatum, *Distribution, analysis, and chronology of petroglyphs in the United States.*

October 19, 1948, 752d meeting, David C. Graham, *The customs and religion of the Lolos, or Fighting with magic.*

November 17, 1948, 753d meeting, Edward A. Kennard, *Anthropology and the Foreign Service* (at Cosmos Club; refreshments served by the Society).

December 21, 1948, 754th meeting, Henry Lee Smith, Jr., *Language and culture.*

The Society was able to increase its program budget from $105 in 1948 to $190 for 1949. After considering the American Anthropological Association's proposal to do all billing for its affiliated societies, a special committee reported its findings to the membership. This report was also forwarded to the Executive Board of the A.A.A. for its consideration at the December 1948 meetings.

Marshall T. Newman, *Secretary.*

Obituaries

Stephen Reid Capps.—It is my sad duty to bring to the formal attention of the Washington Academy of Sciences the sudden termination of the career of one of its long-time members and a former president of the Geological Society of Washington, Dr. Stephen Reid Capps, who was born on October 15, 1881, and died on January 19, 1949.

First and foremost, Dr. Capps was always at heart a field geologist. The endless "pushing around" of papers, which unfortunately engulfs the activities of most administrative positions, was always anathema to him, and time after time he chose some arduous field assignment rather than take on duties that would keep him submerged in desk work. He, however, was not one to shirk responsibility, and in his later assignments, when it became necessary for him to devote more and more of his time to administrative duties, he would buckle down to the inevitable desk work with the same determination as he would have approached a particularly boggy portion of his route across an unexplored country, determined to carry out the assignment to the best of his ability.

Much of his success in his field work came through his interest and curiosity regarding all aspects of nature. To him, not only did the different rocks have a story to tell, but so also did each change in the slope of a hillside or the character of the vegetation associated with the different land forms and the materials of which they were built or the animals that ranged in the different parts of the terrane.

Although far from appearing to have a rugged physique—he was slender and over 6 feet 4 inches tall—few could outlast him in getting over ground in the field, and no matter how stiff had been his scrambles and climbs during the day, as a young man he was never too tired to take additional tramps afield to see whether he could not get a mess of fish, or some game, or examine some object that piqued his curiosity. His deftness in using his hands was a constant asset to him whether that skill was utilized in the field, in building a boat in which his party could cross a turbulent stream, in repairing gear, or in devising some gadget that would serve to amuse or be a convenience to his associates. This same skill enabled him, in his leisure hours at home, to fill his house with furniture masterpieces which he built—often from the very start of whipsawing a log into the needed planks.

From the University of Chicago in 1907 he received the Ph.D. degree for his studies of ancient glaciation in the mountains of Colorado. He was first employed by the United States Geological Survey on investigations of water-supply problems in the Central States. Soon, however, he transferred to Alaskan explorations, in which he made notable contributions during the next 28 years. It was during this period that he built a national and international reputation as a reconnaissance geologist, especially adept in the interpretation of phenomena attendant on existing and ancient glaciation and its effect on the sculpture of land forms. He put this great ability to continued national service in his examination of many of the mineral bearing localities in the Territory, notably the gold lodes and placers of the Willow Creek, Yentna, and Kantishna districts, of the coal deposits of the Bonnifield district and adjacent parts of the Alaska Range, and of the copper deposits of the Prince William Sound region and parts of the Copper River region.

His ability as a reconnaissance geologist led to his being selected to carry out certain of the investigations of the petroleum resources of the Alaska Peninsula region and to serve as special consultant to the expedition that was sent out by the Navy to examine extensive tracts in the Aleutian Islands. This special competency undoubtedly was the reason why, in 1920 and in 1922, he was employed by a private commercial company to conduct extensive explorations for petroleum in Palestine and adjacent areas in the Near East.

His monumental compendium on the *Geology of the Alaska Railroad region* (U. S. Geol. Surv. Bull. 907) gave him a remarkable opportunity to demonstrate his broad knowledge and ability to coordinate a tremendous body of material by bringing together and summarizing not only his own explorations in different parts of that area, but also to synthesize and present as a unit all of the work that had been done by others during more than half a century of endeavor in that particularly difficult tract which lies athwart the general trend of geologic structures in central-southern and parts of interior Alaska.

Perhaps overemphasis has been given to Capps's Alaska work, because the results have been made public through his printed reports, and therefore are freely available. Much of his later work was concerned with investigations the results of which have not yet been made widely accessible, or were of an administrative character that do not lend themselves to discussion. Suffice it to say that these studies led him, as a member of the Geologic Branch, to investigate critically, in the field, certain of the mineral bearing areas in Idaho and Colorado, in the United States, as well as extensive deposits of manganese, in Brazil.

From time to time, in his later years, as a member of the Survey group working on problems of Military Geology, he prepared numerous confidential memoranda and reports on various foreign and domestic sources from which the nation could obtain needed materials for the successful prosecution of this country's global war or defense programs. Advice of value that he could furnish to the military agencies of the government was not restricted solely to war materials, but included highly classified strategic subjects that could be best analyzed by a geologist, and for which Capps had special fitness.

Constantly called on to assist in many of the major projects in which the Geologic Branch of the Survey became involved, he was one of the leaders of the group whose technical advice and council were utilized in contributing to the broad planning for the great projects lately under way which looked forward to the development of the whole Missouri Valley region. During 1946–1947 he was engaged primarily in planing the Geological Survey's part in the great reclamation projects which involved not only the Missouri Valley but also the Columbia, Colorado, and the Central Valley of California. This called not only for the highest type of professional insight but also for capacity to coordinate and work with others who approached the problems from diverse and often adverse viewpoints.

High as Capps was rated as an eminent geologist, he was rated even higher as a man and a friend. Witty, stimulating, along whatever line his versatile brain turned, he was never reluctant to express his views, but was never militant in so doing. He was ever ready to befriend all whom he could help. He left an ineradicable impression on those with whom he came in contact and enduring contributions to the science to which he devoted his great talents.

PHILIP S. SMITH.

SAMUEL HENRY McCRORY was born in Iowa City, Iowa, on May 5, 1879, to Charles Robert and Ruth Ann (Stevenson) McCrory. In 1904 he graduated from the State University of Iowa with the degree of B.S. in civil engineering. Twenty-two years later the honorary degree of A. E. (agricultural engineer) was conferred upon him by Iowa State College in recognition of his outstanding work in that field.

In 1907, following a short period in private practice at Sioux City, Iowa, he entered Government Service as instrument man in the irrigation and drainage investigation branch of the Office of Experiment Stations of the United States Department of Agriculture. His work at first had to do with the development of plans for farm and community drainage and for flood protection. He rapidly passed through the various grades of the organization until in 1913 he was appointed chief of the division of drainage investigations. During the ensuing years the scope of his responsibilities was gradually increased until the work under his direction was directed toward research in drainage, erosion control, farm machinery, and farm structures. In 1925 his organization became the division of agricultural engineering in the Bureau of Public Roads. By 1935 the work of his division had grown to such an extent as to justify bureau status, and the Bureau of Agricultural Engineering, with Mr. McCrory as chief, was established in the Department of Agriculture.

During World War II he served as director of the hemp division of the Commodity Credit Corporation of the Department of Agriculture, supervising the construction of about 40 hemp plants in this country. After 40 years in the Department of Agriculture he retired in 1947.

His contributions to agricultural engineering have been widely acclaimed. Not only was he the first recipient of the John Deere Gold Medal (in 1938) but was also made president of the American Society of Agricultural Engineers and life member of the American Society of Civil Engineers and the Washington Society of Engineers.

Samuel McCrory married Blanche Severe in Sioux City, Iowa, on June 30, 1909. They had two daughters, Dorothy Emogene and Ruth Roberta. It was shortly after his return from a mission for the Government to Egypt, Palestine, and countries of Asia Minor and visiting Ruth at her husband's diplomatic post in Italy that Mr. McCrory was suddenly stricken with a heart attack at his Washington home, 6811 Sixth Street, N.W. He died February 18, 1949.

Samuel McCrory was a lovable character having a wide circle of friends. He had belonged to the Washington Academy of Sciences since 1937 and was a member of the Cosmos Club.

C. A. BETTS.

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ARCHEOLOGY.—*The "Neolithic" problem in the prehistory of India.*[1] EUGENE C. WORMAN, JR. (Communicated by GORDON R. WILLEY.)

For almost a hundred years, since interest in the prehistoric archeology of India first arose, archeologists have discussed the "Neolithic" cultures which existed in that country in ancient times. Archeological literature is full of references to "Neolithic" implements and peoples, and the accuracy of the use of the term has not been questioned. Yet, during the course of an extensive study of Indian prehistory, the writer has become impressed with the number of times the word "Neolithic" has been erroneously employed. He has therefore investigated the so-called "Neolithic" objects displayed in Indian museums and reported in literature in an attempt to discover just how many of them really merit the application of that term. The present paper constitutes a summary of the results of that investigation.

By definition, Neolithic culture is Stone Age culture. According to the writer's understanding of the matter, the primary trait that sets Neolithic culture apart from other Stone Age ones is that of intentional food-producing as opposed to mere food-gathering as a means of subsistence. This trait is found in the form of agriculture or animal husbandry or a combination of the two. Secondary traits, often but not always associated with Neolithic culture, are pottery and smoothed stone tools. These were apparently first produced by more or less sedentary peoples as a result of needs for storage and cooking vessels and for land-clearing or agricultural implements. A full Neolithic archeological site may therefore be characterized by the presence of domesticated plants or animals and by pottery and smoothed stone tools. The first three of these items are common to the highly developed material cultures of the present day, however, and they can not be taken by themselves as criteria of Neolithic culture. Neither can the presence of smoothed stone tools be universally accepted as an indication of the Stone Age date of a site. The absence of metal in an archeological complex containing the above-mentioned traits or stratigraphic evidence proving that the complex existed prior to the introduction of metal into the area is also necessary to the identification of a Neolithic site or culture.

The large majority of "Neolithic" artifacts collected in India consists of smoothed stone tools. Most of these are axes or adzes, but other types such as hammerstones, ringstones, rubbing and grinding stones, and mortars are also represented. Some pottery and a few other objects are also classed as "Neolithic" because of their association with smoothed stone implements. Of all the material available, however, only smoothed stone axes and adzes have been collected and reported in sufficient numbers from enough parts of India to make a study of them practical. Thus, the writer has confined his study to these tools, believing that whatever information they produce will be corroborated by the evidence of other types of artifacts.

Most smoothed stone axes and adzes displayed in Indian museums and described in archeological literature were apparently

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[1] Received February 9, 1949. This article is based upon nine months of archeological field work in India during 1938–39, as well as upon a bibliography of over 150 titles dealing specifically with Neolithic-like objects found in India and of an almost equal number of titles dealing with the Middle East and the Far East. A more detailed treatment of the same material is in the hands of the library of the Peabody Museum, Harvard University, Cambridge, Mass. As all bibliography used in this article antedates the partition of India in 1947, the term "India" as used herein includes the areas now comprising both India and Pakistan.

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collected from the ground surface. They are without archeological context and are therefore of little value for cultural or chronological classification. Some have been found in the homes of modern Indian villagers, who regard them as thunderstones and who keep them for their imagined protective or curative properties (Fox, 1873; Walsh, 1904). A few have been excavated from datable historic sites where metal implements and epigraphic material were also found (Marshall, 1915). Some have been taken from supposedly prehistoric "Iron Age" urn burials, in which they were definitely associated with iron implements and pottery (Laffitte, 1932). In a few cases, smoothed stone celts have been collected from the surface of sites where the presence of considerable cultural debris, apparently lacking in metal objects, is visible but where excavation is needed to determine the date of the site.[2] In a very few instances, as at Bursahom, Kashmir State (DeTerra, 1942) smoothed stone celts have been uncovered in levels definitely underlying strata containing metal objects or other more or less datable, chronologically late artifacts. In no case, however, has any of these stone celts been recovered from a site in which it was positively associated with an archeological assemblage unquestionably representing a pre-metal, Stone Age, food-producing culture. There is therefore no Indian site or implement yet known to this writer that can surely be called Neolithic.

Nonetheless, it being unlikely that the thousands of smoothed stone artifacts in India are derived solely from Metal Age contexts, the writer made a typological examination of Indian smoothed stone axes and adzes in an effort to determine whether anything significant about them could be discovered regardless of their cultural affinities.

The writer plotted the sites at which Indian smoothed stone celts have been found. They occur as shown in Fig. 1, almost exclusively in Assam, Bengal, and in eastern, central, and southern India, south of the Ganges River flood plain, north of Pudukkottai State in Madras Presidency, and east of a line drawn in a south-southwesterly direction from Lucknow or Cawnpore in the United Provinces to Goa, the Portuguese territory on the southwest coast of India. Some celts are found also in parts of Kashmir State and the Punjab in north India, but the area in which they occur is not well defined (DeTerra, 1942; Vats, 1940). A very few celts or celtlike objects have been found in the Copper-Bronze Age sites of Mohenjo-daro in Sind and at Nal and Rana Ghundai (near Loralai), Baluchistan (Marshall, 1931; Mackay, 1937–38; Hargreaves, 1929; Ross, 1946). Aside from a few possible axes or adzes, reported but not thoroughly described by P. E. P. Deraniyagala (1943, 1945) as occurring in the Balangoda area of south-central Ceylon (approximately lat. 6°40′N., long. 80°45′E.), no celts have been found on that island.

The fact that the distribution of these celts is seen to be confined to the eastern half of India is probably significant. The presence or absence of celts in any given area apparently does not depend upon the presence or absence of suitable raw material for their manufacture. Neither can the rarity of recorded celt finds in northern India be explained by lack of exploration. One is therefore led to an interesting speculation as to the point of origin of most Indian "Neolithic" celts and their techniques of manufacture. This is that they were derived from the Far East rather than from the Middle East. At first glance this theory seems unlikely, in view of the fact that Neolithic culture is generally supposed to have originated in the highlands of the Middle East or Central Asia just northwest of India and to have spread from there throughout the Old World. Nevertheless, it can be supported to some extent by various kinds of evidence, of which only that supplied by stone tools is considered in detail below.

A preliminary survey of Indian celt types indicates that they were made by two basic techniques. Technique I seems to have included two main steps, chipping and smoothing, with sometimes an intermediate pecking step between the two. The chipping consisted of the removal of coarse flakes from one or both faces of a core or large flake until (a) in the case of short, broad tools a radial chipping pattern had been formed, and (b) in the case of longer implements two parallel lines of flake scars meeting in a longitudinal ridge had been produced. The transverse section of a tool made by this technique is ovoid, lens-shaped, trapezoidal, or triangular. Smoothing, mainly around the cutting edge, followed the chipping, although pecking as a further shaping step was sometimes employed after the chipping and before the smoothing of the implement. Technique II consisted only of chipping and smoothing. The chipping included the removal of flakes from the sides as well as the faces of a core or large flake until an implement with almost flat faces and perpendicular sides had been formed. Further fine retouching then regularized the shape of the artifact. In some instances celts with almost geometrically squared corners and with perfectly rectangular transverse sections were made by chipping alone. The transverse sections of all tools made by this technique are roughly rectangular. Smoothing as used with this technique usually covers more than half the surface of the celt, and a high, shiny polish over most of its surface is common.

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[2] E.g., at an unpublished site discovered by Father L. Faucheux, of Le Petit Séminaire, near Pondichéry, French India, about 1938. Also at Kapgal Hill, Bellary District, Madras Presidency, described in Foote, 1916, and visited by the author.

A subdivision of axes and adzes into types on the basis of shape, cross section, and technique of manufacture reveals the presence in India of 12 basic types, of which all but three are represented by both ax and adz forms. Three adz types have no counterparts among the axes examined by this writer. It need hardly be said that these ax and adz types are wholly arbitrary and that they represent only those implements that appear to the writer to be the most common or distinctive. All grades of variation in shape and section from one type to another may be found. In some cases, too, the identification of types has probably been made on the basis of incomplete data, hampered by the frequent lack of good illustrations. Nevertheless, these types are useful means of working with available information, and they are briefly described below.

The first four celt types form a group, all of them apparently being made by technique I. Smoothing is usually found only around the cutting edge; it rarely covers more than half the surface of the tool.

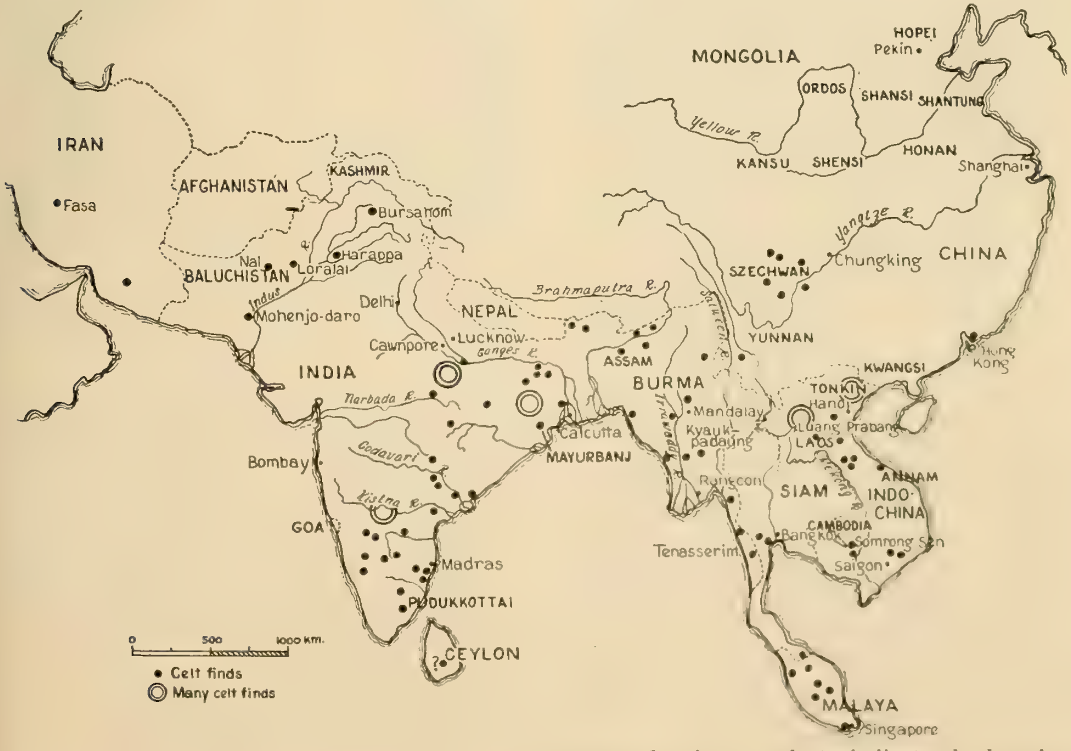

FIG. 1.—Map of celt finds in southern Asia. No attempt has been made to indicate the location of all celt finds in China.

Celt type 1 is rather rare. It is oval in shape. The transverse section is biconvex-lens shaped, oval, or trapezoidal. Specimens include chipped; chipped and partly smoothed; chipped, pecked, and partly smoothed; and completely smoothed forms. Lengths from butt to cutting edge range from 8 to 10 cm in specimens measured by the writer (Fig. 2, *1*). This celt type is found sporadically in east and south India.

Celt type 2, one of the two most common of all forms in India, is of elongated trapezoidal shape. The transverse section is planoconvex, biconvex, trapezoidal, or triangular in shape. Specimens include chipped; chipped and partially smoothed; chipped, pecked, and partially smoothed; completely pecked but unsmoothed; and completely smoothed varieties. Lengths range from 6 to 15 cm (Fig. 2, *2*). The type occurs commonly throughout north, east, central, and south India wherever celts of any kind are found.

Celt type 3 is the other of the two most common forms in India. It is of triangular shape. The transverse section is biconvex-lens shaped, oval, or almost circular. Specimens are chipped; chipped and partly smoothed; chipped, pecked, and partly smoothed; completely pecked but unsmoothed; or completely smoothed. Lengths range from 7 to 18 cm (Fig. 2, *3*). The type is found in east, central, and south India but not in the north so far as this writer knows.

Celt type 4 is one of the three types found only in adz form. Its shape is generally rectangular although the sides, butt, and cutting edge are somewhat convexly curved in outline. The upper face arches strongly both laterally and longitudinally. The lower face is flattish. The transverse section varies from a high trapezoidal shape to that of a broad oval. The cutting edge is near the lower face. Specimens are chipped; chipped and partly smoothed; and completely smoothed. Lengths run from 7 to 10 cm (Fig. 2, *4*). The distribution of these celts is primarily southern, but they are also found rather rarely in east and central India.

The second four celt types also form a group. Most of the implements representing the group are either completely pecked or completely smoothed, and it is almost impossible in many cases to determine the method by which they were made. The point which seems to set this group apart from the others, however, is that celts in it appear to have been manufactured by both technique I and technique II. The writer has not separated them into 8 types and placed them with the first or the last group because of the frequent uncertainty as to the technique of manufacture.

Celt type 5 is distinguished by its very large size and very thick transverse section. Shapes vary from almost cylindrical or rectangular to triangular. Transverse sections are circular, broadly oval, or square. Most specimens are completely pecked or completely smoothed. Examples include chipped and pecked; chipped and partially smoothed; chipped, pecked and partially smoothed; completely pecked but unsmoothed; and completely smoothed varieties, however. Lengths range from 20 to 25 cm, and the implements are quite heavy (Fig. 2, *5*). The type is found mainly in east India, but it occurs in small numbers in central India and, even more rarely, in the south.

Celt type 6 is tiny in size and trapezoidal in shape. The transverse section is roughly rectangular. Specimens of this type, especially those from east India, are almost invariably completely smoothed. Many are highly polished. A few tools, mostly from south India, show evidence of chipping or pecking before smoothing. Some from east India show only chipping and smoothing. Lengths from butt to cutting edge are 4 to 7 cm, and breadths are sometimes as great or greater than lengths (Fig. 2, *6*). The type is found in east, central, and south India, but most examples come from the east.

Celt type 7 is a rare, tiny form broadly triangular in shape. The transverse section is oval to rectangular. Complete smoothing and a high polish over the whole surface are common. A few specimens show traces of pecking before smoothing. Lengths range from 4 to 7 cm. Breadths are often as great or greater than lengths (Fig. 2, *7*). The type is most often found in east India though a few occur in central and south India.

Celt type 8 is the shouldered adz familiar to most Asiatic archeologists. It does not occur as an ax. It has two basic shapes, one curvilinear, the other rectilinear, as shown in Fig. 2, *8a*, *8b*. The transverse section is ovoid in curvilinear specimens, rectangular in rectilinear ones. Chipped and pecked; chipped and partially smoothed; and completely smoothed specimens occur. Lengths range from 6 to 14 cm. The distribution of the type is confined almost wholly to east India. Rivett-Carnac claims to have discovered one example in central India (Rivett-Carnac, 1883). Cammiade states that the type occurs rarely near the Godavari river mouth in southern India (Cammiade, 1924; Cammiade and Burkitt, 1930). The writer found an apparently unfinished specimen in northern Mysore State in 1939.

The last four celt types can be grouped together as were the preceding ones, the point of similarity being their common man-

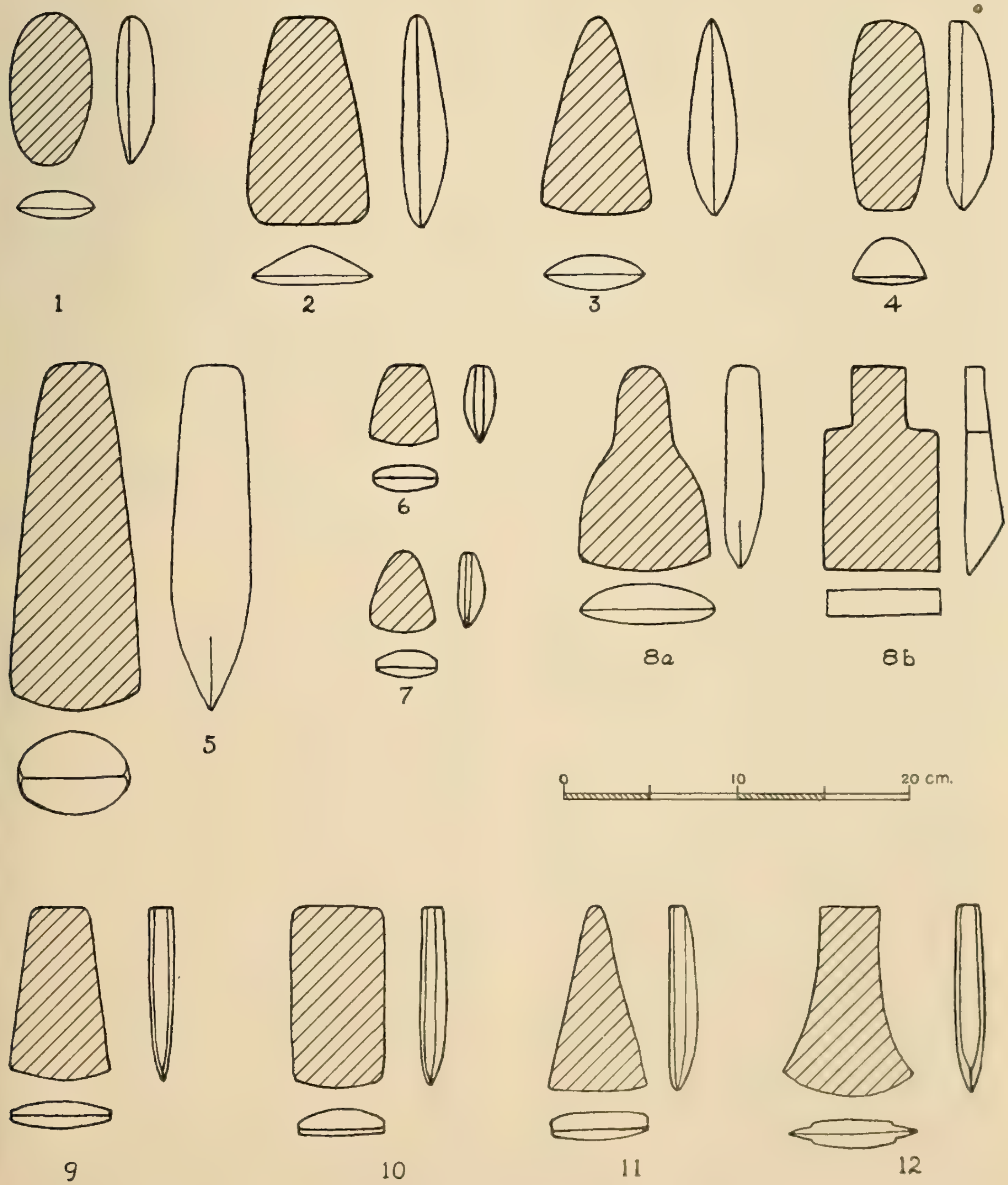

Fig. 2.—Indian celt types

ufacture by technique II. Smoothing usually covers more than half the surface of the implement and a high polish is frequent.

Celt type 9 is trapezoidal in shape and may be either broad or narrow. The transverse section is rectangular. Specimens are chipped and partially smoothed or completely smoothed. Lengths run from 8 to 18 cm (Fig. 2, *9*). The type occurs almost exclusively in east India where it is common. Some examples are found in central India, but none appears in the south. At least four large implements resembling this type were unearthed at Mohenjo-daro, Sind, and two were dug up at Harappa, Punjab (Marshall, 1931; Mackay, 1937–38; Vats 1940). The extremely large size (23 to 32 cm in length), the great weight, and the rarity of these artifacts, however, militate against their having been used for the same purposes as the smaller celts found elsewhere.

Celt type 10 is rather rare. It is rectangular in both shape and transverse section, the sides of the implement being parallel. Shapes range from long and narrow to short and broad. Most specimens are completely smoothed; a few are chipped and partially smoothed. Lengths range from 9 to 12 cm (Fig. 2, *10*). The type is limited entirely to east India. One celt of this type may have been found at Bursahom, Kashmir State, but it is impossible to tell from published illustrations (De Terra, 1942) whether the rectangular shape is the result of the material used in its manufacture or of conscious design on the part of its maker.

Celt type 11 is rare, being found only in adz form. It is triangular in shape. The transverse section is roughly rectangular. Specimens are chipped and partially smoothed or completely smoothed. Lengths run from 5 to 18 cm, but the majority are fairly small (Fig. 2, *11*). To the best of the writer's knowledge, this type occurs only in Orissa and in Mayurbhanj State in eastern India.

Celt type 12 appears to have been copied from a metal prototype. The butt is flat; the sides are curved and flare widely near the cutting edge; and the edge itself is strongly curved in profile. The transverse section is roughly rectangular. Specimens include chipped and partly smoothed as well as completely smoothed varieties. The majority of these implements are highly polished. Lengths run from 7 to 13 cm (Fig. 2, *12*). The distribution is confined to eastern India.

Upon studying the distribution of these three groups of celts one is immediately struck by the manner in which they substantiate a theory for the introduction of celts and celt-making techniques into India from the east rather than the west. Celts of group I contain those types not only the most frequently found in India but also those most widely spread throughout the country. The technique by which they were produced is not greatly refined, the forms of the tools are simple, and smoothing usually covers less than half their surfaces. Celts of group II occur mainly in eastern India, though they are found also in the south and center of the country. Specimens of types of this group are ordinarily more carefully made, more completely smoothed, pecked, or polished, and of more advanced forms than those of the first group. Celts of group III are the least widely distributed of all types in India, three of them being entirely confined to eastern India. The care and technical skill with which these implements were made bespeak for their makers a considerably greater stone-working skill than that found among the manufacturers of the first two groups of celts.

The fact that each succeeding group of celts is not only technically more evolved than the preceding one but also more limited in its distribution toward eastern India, the only part of the country where all 12 celt types occur, suggests the following:

(*a*) That celts of the first group are the oldest and most basic of all types in India.

(*b*) That celts of the second group are intermediate in date and that they reflect the introduction of a new manufacturing technique and some new celt shapes into India from the east.

(*c*) That celts of the third group are the latest and most highly developed of all types in India. Their distribution definitely indicates that they are the most recent arrivals in India and that they are derived from the east.

There is no archeological proof for the above conclusions, but there are as yet no clear-cut arguments to refute them. It therefore appears, if the above theory is true, that stone implements from India should resemble those from eastern Asia more closely than those from the Middle East. There should also be some evidence to prove that the chronological dating of celt types suggested above is correct. Whether or not this is so can be demonstrated by a comparison of Indian and foreign celt types as described below.

THE MIDDLE EAST

Unfortunately, an attempt to compare Indian and Middle Eastern celt types is hindered from the outset by the following facts:

(*a*) The comparison of Indian and Middle Eastern celts has to be made, not between implements in immediately adjacent areas, but between tools found as far apart as central India and western Iran. Aside from a few celts excavated by De Terra in Kashmir, the only Indian celt finds known to the writer from west of central India are four large implements unearthed at Mohenjodaro, five celts found at Harappa, two celts discovered at Nal, Baluchistan, and one undescribed celt collected at the Rana Ghundai mound, near Loralai, Baluchistan. All but the last of these definitely occurred in Metal Age levels, and they are not typical either of a Neolithic culture complex or of the one in which they were found. The only stone celts known to the writer from Afghanistan, Russian Turkestan, and eastern Iran are two well-worked stone axes found by Sir Aurel Stein in low levels of a Metal Age mound at Bampur, southeastern Iran, at about latitude 27°15′N, longitude 60°30′E, and two celts from sites near Kanakan and Kamalabad in the Fasa Valley, southern Iran (Stein, 1934, 1936, 1937).

(*b*) In western Iran and Iraq, where celts are more often discovered, they are seldom well described or illustrated. In site after site where stone celts occur, they are said to display no typological development and, therefore, to be of no value for dating purposes. Consequently, they are considered less important to the excavator than pottery wares, decorative motifs, and other changeable culture traits, and they are left either undescribed or only very generally described. As a result of this custom of neglecting finds not useful for dating purposes, the writer is able to base his study of Middle Eastern celt types upon tools from only 20 sites.[3]

(*c*) At the majority of sites from which stone celts have been described, the earliest habitation layers containing these implements also contain copper or other metal objects indicating that the makers of the stone artifacts were already at the threshold of a Copper or Bronze Age. Most celts at these sites occur in levels definitely of Metal Age date.

(*d*) In the few sites where apparently pure Stone Age levels are found, neither the levels themselves nor the celts found in them are well described.

(*e*) Finally, while many Middle Eastern stone celts display evidence of the techniques by which they were manufactured, a great number are completely or almost completely smoothed and show no such traces. In these cases only the relative angularity of their shapes and cross sections can furnish clues as to their relationships with Indian celts made by techniques I and II.

Thus, one has to carry out a comparison of Indian and Middle Eastern celt types with the discouraging knowledge that all conclusions reached may be unsound because of the fragmentary nature of the evidence upon which they are based. Furthermore, difficulties arise from the fact that stone celts from the Middle East are no better criteria of Neolithic culture than they are in India, there being few truly Stone Age implements and no chronological scale of development of Middle Eastern types against which to check undatable Indian tools. Comparisons of Indian and Middle Eastern stone implements have to be made on the basis of typology and distribution alone, without regard to the date of the artifacts. Nevertheless, such comparisons bring out a few points that are worth mentioning.

In Palestine and Syria a considerable proportion of all celts discovered in both Neolithic and Bronze Age levels are chipped or chipped and slightly smoothed around the cutting edge. Other implements are more carefully made and are frequently completely smoothed. Most tools, however, whether slightly or completely smoothed, are of simple types similar to those of the Indian types 2 and 3. They appear to have been manufactured by a technique like that of the Indian technique I. Possibly not more than a quarter of all celts, most of which are completely smoothed, recall the angular Indian types 9 and 10 which are made by technique II. The Indian types 4 and 5 and the technically advanced types 8, 11, and 12 are completely absent from this area. In south Turkey and north Iraq, too, most celts are like the simple Indian types 2, 3, 6, and 7, though they are more often completely smoothed than they are in Palestine or Syria. Celt types 4, 8, 11, and 12 are also missing in this region. Pecking as a means of shaping a tool seems to occur but rarely in any of the above-mentioned areas.

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[3] Al 'Ubaid, Chagar Bazar, Jemdet Nasr, Kish, Nineveh, Nuzi, Tall Arpachiyah, Tell Hassuna, Tepe Gawra, and Uruk in Iraq; Sialk and Tepe Hissar in Iran; Ain Shems, Carchemish, Jedeideh, Jericho, and Teleilat Ghassul in Palestine and Syria; and Alaca Huyuk, Alishar Huyuk, and Mersin in Turkey.

In southern Iraq and Iran, where the basal levels of almost all sites already show traces of metal, stone celts as a whole are not so crudely made or so poorly finished as they are farther to the west and northwest. Here stone tools usually display a smooth finish, a greater tendency to angularity of form, and a greater variety of shape than they do to the westward. Only one-half to two-thirds of the celts here are similar to the simple Indian types 1, 2, 3, 6, and 7, and most of these artifacts are almost wholly smoothed. In addition, a much higher percentage (one-third to one-half) of the celt types here are similar to the Indian types 9, 10, and 11, and they, too, are ordinarily smoothed over the greater part of their surfaces. A very few type-8 celts of the round-shouldered variety found at Al ʻUbaid, Kish, and possibly Sialk constitute an exception to this general rule, being merely chipped or chipped and slightly smoothed. Celt types 4, 5, and 12 and the square-shouldered variety of 8 are missing. It is difficult to tell from published illustrations what part was played by pecking in the manufacture of any of the above celt types.

The impression gained from a comparison of both Stone Age and Metal Age stone celts from Palestine, Syria, south Turkey, and north Iraq with those from southern Iraq and Iran is that the implements from the former area are more primitive and of fewer types than those found in the latter region, regardless of the date of the levels in which they occur. In other words, the celts found to the westward are more often like the supposedly early Indian types made by technique I, while those to the eastward more frequently resemble the later Indian types made by technique II. Interestingly enough, the area where the simplest celt forms are found is exactly that in which almost all of the sites known to contain true or early Neolithic levels exist. The relatively early dates of the Neolithic influences in this area may therefore be reflected in the primitiveness of celt types as a whole throughout both the Neolithic and Metal Age periods. In addition, there is some evidence to indicate that the lower valleys of the Tigris and Euphrates Rivers were settled at a later date than the headwaters. It thus seems reasonable to suppose that persons inhabiting that region had more highly evolved techniques of celt manufacture than their predecessors to the north and west. The point cannot be proved, however, until further excavation has taken place.

The significance of the comparison of Indian and Middle Eastern stone celt types can be summed up in a few words as follows:

(*a*) The evidence, such as it is, suggests that the earliest Neolithic sites in the Middle East are north and west of the Tigris-Euphrates River basins and that the most ancient sites closer to India are of very late Neolithic or Metal Age date. There is no evidence to suggest that the earliest celts in India were brought into that country from regions immediately to the westward.

(*b*) The closest resemblances between Indian and Middle Eastern celt forms are between those types such as 2, 3, 6, 7, 9, and 10, which are commonly found throughout the world. The absence in the whole Middle East of specifically limited types such as the square-shouldered variety of type 8 and types 4 and 12 argue for a general rather than a specific cultural connection between the two areas. This contention is further borne out by the fact that painted pottery, which occurs widely throughout the Middle East in association with stone celts does not often occur in India east of the Indus River basin in prehistoric times.

(*c*) There is a slight suggestion in the Middle East that typologically cruder celts are earlier in date than better finished ones, just as was presumed to be the case in India. Theoretically, this seems perfectly reasonable. Actually, it has not yet been stratigraphically proved.

Simple though these conclusions may be, they do not contradict the expectations aroused by a study of stone celts in India. Rather, they support the theory of an eastern origin for the "Neolithic" techniques of stone-working in India. One may therefore turn to a comparison of Indian and Far Eastern celt types with the hope that it will be more enlightening than the one just completed. Fortunately, this hope appears to be justified though the evidence supporting it comes from regions somewhat removed from eastern India.

THE FAR EAST

Assam and Burma.—In Assam and Burma, as in peninsular India, the great majority of known Neolithic-like stone celts are unassociated finds picked up from the ground surface or purchased from local villagers. Of the few that have been recovered *in situ* most are isolated celts dug up from shallow depths during house-building, road-making, or ditching operations (Brown, 1917; Cockburn, 1879; Hutton, 1926). The writer knows of only one celt, found by Drs. De Terra and Movius near Kyaukpadaung, Burma, which occurred *in situ* in positive association with other objects such as waste flakes and small chipped stone scrapers, points, and cores (De Terra and Movius, 1943). Assamese and Burmese celts, therefore, are no better criteria of Neolithic culture than are Indian ones.

Most celts in Assam and Burma have been collected from (*a*) the Khasi and Naga Hills in Assam, (*b*) the hills on either side of the Irrawaddy River Valley in southern Burma, and (*c*) the hills along the Burmese seacoast from Arakan in the west to Tavoy, Mergui, and Tenasserim in the south. They are apparently not found in the flat lands of the large river flood plains, and only a very few have been discovered in the relatively unexplored highlands of central and northern Burma. Because of the paucity of archaeological exploration in this part of the world, however, it is not certain to what extent this distribution is the true one or not. It may represent only those areas in which settlement by Europeans is thickest.

Typologically, celts of types 1, 2, 3, 5, 6, 7, 8, and 9 have been found in Assam and types 1, 2, 3, 6, 8, 9, and 10 in Burma. The only types not found in any part of the area are 4, 11, and 12, all of which are rare in India. As all three of these types are clearly present in nearby regions of India and in Indo-China and Malaya, their absence in Assam and Burma may be a matter of spotty collecting. The distribution of celt types in Assam and Burma is such that no one type or group of types can geographically be separated from the others. Thus, there is no indication of the relative dates at which these celt types were introduced. This situation is that which might be expected if Assam and Burma were the corridor through which celt-making techniques entered India.

Little else can be said about this area, but as there is no apparent gap in celt distribution between India proper and Assam and Burma, it seems reasonable to suppose that future archeological excavations in the latter regions will uncover the remains of cultures much like those of eastern India.

Siam.—Siam is even more of a terra incognita to the prehistoric archeologist than are Assam and Burma. The only archeological excavations known to the writer to have taken place in prehistoric sites there are those made by Fritz Sarasin in a few caves in north and south Siam. These were reported in 1933 (Sarasin, 1933). In these caves Sarasin found a culture sequence which was represented at the top of the deposits by bricks and pottery of relatively modern date. Under these lay potsherds decorated with cord-marked or stamped designs reminiscent of late prehistoric ones from Indo-China. The lowest layer of the deposits contained chipped stone implements, animal bones, and mollusk shells. The artifacts, which included axes, points, and scrapers, were said to resemble Hoabinhian ones from Indo-China (to be described below).

In addition to these excavated remains a few surface finds of celts have been made at Chong, Surat, Petjaburi, and Betong in south and peninsular Siam and near Nom Pladuk on the Bangkok-Moulmein railway.[4] These include nicely finished celts of types 8 and 9 and a beaked adze of a type found in Malaya and Indonesia. Other smoothed stone tools reported by Kerr and Seidenfaden[5] as found in north and east Siam are not described in any literature available to the writer.

The stratigraphy and implement types of the excavated cave sites, as well as the typology of the surface finds in Siam, are much like those of Indo-China and Malaya. While little of significance can be said about them, they lend credence to the supposition that the Stone Age cultures of Siam were related to those of the countries round about.

Indo-China.—The key to the late Stone Age culture problems of the whole of southeast Asia is found in Indo-China. Here one no longer has to deal with isolated surface finds but with a large number of excavated sites in which apparently pure, though undatable, Stone Age culture complexes exist. The majority of sites occur in caves and rock shelters near Hoabinh and in the Bacsonian limestone massif in Tonkin province. Scores of these sites have been found to contain shallow, unstratified earth deposits, seldom more than a meter deep, in which remains of a single, homogeneous culture phase occur. A few cave and shelter sites contain deposits up to 4 meters deep, in which clear-cut geologic layers are lacking but in which several successive culture phases are apparently represented. In addition to the caves and rock shelters in Tonkin and elsewhere, a number of open air kitchen middens have been excavated along the coast of Annam and in the interior of Cambodia. These middens are sometimes several meters deep, but most of them, unfortunately, enclose elements of only one typologically rather mixed phase of culture.

The stone implements from the deeper cave and shelter sites display a typological evolution from crude, chipped or chipped and slightly smoothed stone tools found at the base of the deposits to well-shaped, finely smoothed stone artifacts at the top. Pottery occurs only in the upper levels with the more advanced stone tools. On the basis of the apparent cultural evolution represented at these few deep sites, French archeologists have constructed a chronological scheme of cultural development into which material from the single-period sites has been fitted. The scheme is primarily typological, but it is supported by a certain amount of stratigraphic evidence which lends it some degree of accuracy.

According to this scheme, the earliest post-Pleistocene archeological remains in Indo-China are those of the Hoabinhian complex, found in the region near Hoabinh, Tonkin (Colani, 1927). They have been divided into three periods—early, middle, and late.

In the early period, the stone implement industry is based on rounded river pebbles, roughly chipped at one end or on one face only. Types include pebble choppers, oval shaped implements, pyramidal tools, a few chipped short-axes or "haches courtes," points, and scrapers. Large numbers of fresh-water mollusk shells and infrequent bones of large land mammals, including *Elephas* and *Rhinoceros*, testify to the diet of the people. Neolithic traits are conspicuously absent.

In the middle period, stone implements are of slightly better workmanship. Choppers, oval-shaped tools, axes, pyramids, discoid implements, smoothed pebble celts apparently made by grinding down one end of a natural pebble to a cutting edge, chipped and slightly smoothed celts, chipped short-axes, points, scrapers, and polishing stones occur. The celts resemble the Indian types 1 and 2 in appearance and manufacture. Bone points and spatulae are found in small numbers. Mollusk shells and some large mammal bones are found. The Neolithic trait of stone-smoothing appears here for the first time.

In the late period, the stone industry continues a trend toward finer and smaller implements. A few choppers, ovoid tools, discoid implements, chipped and partially smoothed celts, short-axes, points, large rectangular and ovoid scrapers, crescentic scrapers derived from short-axes, and a large number of small triangular, ovoid, or variously shaped points and scrapers occur. The small points and scrapers are said to be the most numerous of all tool types and to represent a distinct departure from the earlier large tool tradition. They are said to be the most striking feature of the Late Hoabinhian stone industry. A few bone blades or spatulae still exist, and a few smoothed bone axes are found. Pottery occurs for the first time. The usual mollusk shells and wild animal bones are present. There is still no trace of agriculture or of domesticated animals.

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[4] COLLINGS, 1936; EVANS, 1926; SARASIN, 1933; and material collected by H. R. van Heekeren while he was serving as a Japanese prisoner during the recent war.

[5] KERR, A., and SEIDENFADEN, E., *Siam, nature and industry*: 60. Bangkok, 1930. Mentioned in Sarasin, 1933.

The Bacsonian culture complex which developed in Tonkin province not far to the northeast of the Hoabinhian one, was in many ways similar to the latter (Mansuy, 1909, 1924, 1925a, 1925b; Mansuy and Colani, 1925). It, too, has been divided into early, middle, and late phases, the implements in which display a gradual evolution from crudely chipped to finely smoothed types.

In the early period, the majority of stone implements are chipped into irregular shapes similar to those found amongst Hoabinhian tools. Ovoid artifacts, discoid tools, small axes or points, chipped and partially smoothed celts, large chipped scrapers of elongated ovoid form, pestles or grinding stones, hammerstones, and elongated narrow pebbles with parallel rows of grooves along their sides are found. Celts are like the Indian type 1 specimens. Fresh-water mollusk shells and infrequent bones of Bovidae, Suidae, and Cervidae occur with the implements. Of typical Neolithic traits, stone-smoothing is rare, and traces of agriculture, animal husbandry, and pottery are absent.

In the middle period, implement complexes show an evolution away from the oval chipped, Hoabinhian-like tools toward triangular and trapezoidal celts with smoothed cutting edges. The stone industry includes celts of the Indian types 1, 2, 3, 6, and possibly 7, chipped oval tools, large ovoid scrapers, smaller chipped scrapers or retouchers, pebble polishing stones, elongated smoothed pestles, discoid rubbing stones, stationary mortars, and the elongated grooved pebbles of unknown use. A few bone awls are found. Some shells, presumably shaped for ornamental purposes, also occur. Smoothing of the cutting edges of stone implements is now common. Pottery appears for the first time in this culture sequence and is either plain or cord-marked. Positive traces of agriculture and animal husbandry are lacking. The usual mollusk shells and animal bones are present.

In the late period the stone celts are usually more regular in shape, and they are smoothed over a greater part of their total surface. Celts of the Indian types 2, 6, 8, and 9 occur. Well-smoothed stone rings or bracelets of types also found in parts of Burma and east India also occur. The Neolithic trait of stone-smoothing is common. Pottery is now found in some quantity. It is decorated with incised, cord-marked, and mat-marked designs. There is still no mention in archeological reports of domesticated grains or animals, but the bones of cattle, buffalo, pig, deer, rhinoceros, elephant, bear, primates, and fresh-water turtles are now common for the first time. This fauna seems to represent a change from a shellfish and vegetable food-gathering economy to a more advanced hunting one although the usual shellfish still appear in large numbers.

The cultural remains from the large shell midden at Somrong Sen, south of Lake Tonle Sap, Cambodia, are generally considered to be among the latest Stone Age ones in Indo-China (Anonymous, 1891; Cartailhac, 1890; Mansuy, 1902, 1923; Moura, 1882; Noulet, 1879). Unfortunately, however, the precise nature of the complex or complexes present here can not be determined (*a*) because much of the mound has been disturbed by local villagers who dig out the shells for burning into lime and (*b*) because no record has been kept of the depths from which individual artifacts have been excavated by archeologists. According to Mansuy, who made the most extensive excavations, the surface layer of the mound contained large numbers of potsherds of wares almost identical to those made by the modern villagers living there. Below this level, Mansuy noted only a confused mass of clayey earth, ash beds, hearths, mollusk shells, animal and human bones, and artifacts (Mansuy, 1902, 1923). The statements of Ludovic Jammes, who described alternating layers of shell and alluvial mud and who claimed to have excavated bronze objects from the upper portions of the midden, have been effectively discredited by Louis Finot (Finot, 1928). Mansuy dug large parts of the site without finding a single article of metal, and earlier visitors who collected metal objects at Somrong Sen apparently bought all of them from the modern villagers living there. For the moment, then, one can only assume that the bulk of the midden contained nothing but Stone Age artifacts.

The stone industry from the midden includes celts of the Indian types 2 or 10, 4, 6, 8, 9, and 11, narrow chisels, a few hammerstones, a few polishing stones, small stone discs or cylinders, and stone rings or bracelets similar to those from Tonkin, Burma, and east India. In addition to the stone tools, the Somrong Sen midden contained bone arrowheads, points, chisels or burins, fishhooks, and miscellaneous items; shell rings or bracelets, discs, pendants, and beads; a few marine shells used as ornaments; and a considerable quantity of plain or decorated handmade pottery. Decorative motifs consisted of incised, indented, punctate, carved, and applique designs in straight or curved line geometric figures. Cord-marking was rare and mat-marking absent so far as this writer could determine. Domestic animals may be represented for the first time in Indo-China, a dog just like the modern Annamese species being found in the faunal assemblage here. Other animals include cattle, deer, pig, rhinoceros, elephant, (?) tiger, reptiles, and birds. Traces of agriculture are still lacking insofar as reported finds are concerned.

Mansuy also obtained from the villagers at the site of Somrong Sen a triangular arrowhead with tang and wings, a cylindrical shank or stem from some unidentified object, a rough chisel, a large fishhook, a simple ring, and four bells, all of which were made of either copper or bronze (Mansuy, 1902, 1923). Not one of these articles was actually excavated by him from the mound. J. Moura, who sent a collection of three rings, seven ring fragments, an ax, two arrowheads, a hook, and two plaques to France in 1877, also obtained his material from the modern villagers rather than from excavations (Moura, 1882; Noulet, 1879). Ludovic Jammes, who stated that he examined Somrong Sen and 14 or 15 other sites in the vicinity, claims to have dug pits in four of the sites and to have discovered objects of bronze associated with human bones. He sent to France a collection of five axes, some chisels, a spearhead, a knife, some rings, a hook, and some bells, all either of copper or bronze (Cartailhac, 1890; Finot, 1928). These artifacts are apparently of varying date, and it is not known from what site each one of them was excavated. It is therefore impossible to point to a single object of this collection as having been found positively at Somrong Sen. Since all kinds of remains of widely divergent dates occur near Lake Tonle Sap, it can not be stated with certainty that any metal artifacts obtained from the villagers at Somrong Sen definitely come from that mound rather than from some other. Some of the copper and bronze implements reputedly from Somrong Sen resemble artifacts which were in use in southeast Asia up to or after the beginning of the Christian Era. If they actually come from the upper levels of the midden, both they and the stone implements immediately underlying them have to be considered to be of relatively late date.

Stratigraphically, the sequence of early, middle, and late phases within the Hoabinhian and Bacsonian culture complexes as described above is fairly well fixed by data from a few deep sites. The relative chronological position of the Hoabinhian, Bacsonian, and Somrong Sen complexes as a whole, however, is not so clearly demonstrable. It is based on the similarity of artifact types at various stages of cultural development. The Mid-Hoabinhian and Early Bacsonian phases are equated because of the presence in them for the first time of smoothed stone celts. The Late Hoabinhian and Mid-Bacsonian phases contain the first pottery. The Late Bacsonian and Somrong Sen phases contain celt types not previously found, and pottery occurs in both of these phases in much greater quantity than before. The sequence of cultures according to this correlation is therefore somewhat as follows:

	Late Bacsonian..	Somrong Sen
Late Hoabinhian.	Mid-Bacsonian ...	
Mid-Hoabinhian .	Early Bacsonian	....
Early Hoabinhian	....	....

If this sequence can tentatively be accepted, the significance of the Indo-Chinese finds with regard to those discovered in India is obvious. The Mid-Hoabinhian and Early Bacsonian culture phases contain celt similar to the Indian ones of types 1 and 2, here stratigraphically shown to be the earliest in Indo-China just as they were claimed on typological grounds to be the earliest in India. The Late Hoabinhian and Mid-Bacsonian archeological complexes contain celts of types 1, 2, 3, 6, and possibly 7. The likenesses of Indian and Indo-Chinese celts are now shown by four or five rather than two types. At this same time, similarities of chipped as well as smoothed stone implements in India and Indo-China become obvious. In collections from Indian sites near the southern border of the Deccan,[6] the writer has found chipped ovoid and elongated choppers, bifacially chipped axes, chipped axes, chipped pyramids or discs, chipped short-axes, short-axes with smoothed cutting edges, crescentic scrapers of the type derived from the short-ax, large rectangular and ovoid scrapers, rough triangular points, flake blades, small points made of thin flakes, discoid and rectangular rubbing stones, hammerstones, and pestles, almost all of which would fit into a Late Hoabinhian or Mid-Bacsonian implement series. The celts found at these sites also include types not appearing prior to the Late Hoabinhian or Mid-Bacsonian periods. Late Bacsonian and Somrong Sen celts, presumably the latest found in Indo-China, include forms similar to the Indian types 2, 4, 6, 8, 9, 11, and possibly 10. Of these, at least two types are believed on typological grounds to be among the latest ones in India. There is therefore some stratigraphic proof from Indo-China that celts of types also found in India were introduced into the cultures of that area in the same chronological order as they were believed to have been introduced into India. This stratigraphic evidence supports that from Siam, Burma, and Assam where surface finds and some excavated sites suggest that cultural connections with India exist.

The only point of variance between the sequence postulated on typological grounds for India and that observed in excavated Indo-Chinese sites is the first appearance of the Indian celt types 4 and 8 in the latest Indo-Chinese archeological complexes. Typologically, they belong to the early and intermediate celt groups in India. The author cannot now determine what the true position of these types may be.

Of the four Indian celt types 5, 7, 10, and 12 not positively reported from excavated sites in Indo-China at least one has been collected there in surface finds. This is the celt type 12 that occurs in the area around Luang Prabang, Laos.

In spite of certain discrepancies and gaps in the evidence, the conclusion that the smoothed stone celts of Indo-China are related both typologically and chronologically to similar tools in India is hard to avoid. Material from actual excavations in Indo-China bears out in considerable detail the suggestions of relationship evoked from a study of fragmentary remains in Burma and Siam, and the few but important stratigraphic data seem to confirm points merely implied by finds in other countries. One may therefore turn to an examination of Stone Age discoveries in Malaya with the expectation that they will corroborate information already obtained from regions to the northward.

Malaya.—As was anticipated, recent excavations in the central and northern Malay States have uncovered Stone Age culture complexes of much the same type as those found in Indo-China.

In Kelantan, the lower layers of cave and rock shelter sites contain Hoabinhian-like choppers, ovoid implements chipped on one or both sides, and possibly short-axes (Noone, 1939; Tweedie, 1940). Pottery is absent. The intermediate layers of the same sites contain finer Hoabinhian-like oval implements, short-axes, scrapers, and small flake tools, together with chipped and partly smoothed celts made by the Indian Technique I and similar in shape to the Indian type 2. A few celts are chipped, pecked, and partially smoothed and have thick cross sections. These resemble the Indian celt type 5. Pottery is present but rare. The uppermost levels contain angular celts with rectangular cross sections, chipped and smoothed over more than half their surface in a manner resembling that of the Indian Technique II. These are like the Indian celt type 9. In addition, beaked adzes and waisted axes, not found in India, appear. Black, dark brown, and reddish pottery of plain or cord-marked and incised varieties similar to those from Indo-China to Burma occur. Fresh-water mollusk shells and the bones of cattle, deer, pigs, bears, and primates come from these sites, but none of the animals is of a domesticated type and no evidence for the practice of agriculture is present.

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[6] Especially in a collection made by the writer at Bellary, Madras Presidency, and in a collection made by the Archeological Department, Hyderabad State, Deccan, at Kotegal, Raichur District, Hyderabad.

In Perak, Kedah, Perlis, and Pahang, the same general sort of thing has been excavated from cave and shelter sites (Callenfels and Evans, 1928; Evans, 1928; Collings, 1936, 1937b, 1937c).

Surface finds in the north and central Malay States include celt types similar to the Indian types 1, 2, 5, 8, 10, and 12, some of which have not yet been found in excavations (Collings, 1936, 1937a; Winstedt, 1935).

Thus it appears that the celt types and cultural stratigraphy of Malaya are much the same as those from other parts of southeast Asia.

China.—On turning to China one finds the situation there a bit more complicated. North China is archeologically the best known portion of the country. Yet an examination of supposedly Neolithic finds from this region shows that few of them are derived from scientific excavations, that the majority of those few are imperfectly described, and that all of them come from sites dating from periods immediately preceding the introduction of metal. The presence in north China of earlier Neolithic peoples is postulated almost entirely on the basis of typological evidence.

In the now-arid regions of the Ordos, Mongolia, and western Manchuria a series of archeological complexes dominated by the presence of microliths has been discovered (Teilhard de Chardin and Pei, 1944). Unfortunately, these occur primarily at surface sites which defy exact dating.

In the loess regions of Kansu, Honan, Hopei, Shansi, and Shensi provinces in northern China, culture complexes referable to an Early Neolithic period are entirely lacking. Only a few surface finds of chipped stone tools suggest the presence there of early post-Palaeolithic peoples (Cheng Te-k'un, 1941, 1942; Teilhard de Chardin and Pei, 1944).

In northwest China, however, particularly in Kansu, a series of Late Stone Age and Early Metal Age archeological complexes have been described by J. G. Andersson (Andersson, 1925, 1943). These complexes are known primarily from painted pottery and stone objects. Using painted pottery as his main criterion, Andersson has divided the Kansu material into six groups, three representing "Neolithic" cultures and three illustrating Early Metal Age ones. The three "Neolithic" groups have been named Ch'i Chia, Pan Shan, and Ma Chang, after the type sites at which they were found. They are stated to have existed chronologically in the order given, but proof for the statement is not entirely satisfactory. Typologically, all the Stone Age remains are "Late Neolithic," but there is very little evidence to show to what date they actually did belong.

In the loess highlands of north-central China, Late Neolithic assemblages containing painted pottery similar to that in the Pan Shan one of Kansu have been found (Andersson, 1923, 1943). They are best represented at the site of Yang Shao Tsun in Honan Province, where finds of grain, ox, dog, and pig bones, pottery, and smoothed stone tools testify that a Neolithic economy was practiced at the time.

Farther eastward in the Great Plain region along the lower reaches of the Hwang Ho and Yangtze Kiang in northeast China, remains of another widespread Late Neolithic culture complex called Lungshan have been discovered (Liang Ssu-yung, 1940; Beath, 1941; Wu, 1938; Archeologia Sinica, 1934). The stone implements of this complex resemble those of the Pan Shan and Yang Shao ones farther west, but the pottery is somewhat different. Its two most distinctive wares are an unpainted, fine, wheelmade, dark gray to black ware and an unpainted, coarse, handmade, brown to dark gray ware usually covered with coarse textile marking.

The exact chronological relationship between the western highland and the eastern lowland complexes is somewhat uncertain.

Both may have been contemporary for a considerable period of time. Evidence available at such sites as Hou-kang, Yang Shao Tsun, and Anyang in Honan and at Lungshan (Ch'eng-tzu-yai) in Shantung indicates that both immediately precede the date of the introduction of metal into China.

Since the precise relationships and relative chronologies of these north Chinese Neolithic complexes are still uncertain, smoothed stone implements taken from them cannot yield much but typological information. Artifacts from Late Neolithic and Metal Age sites or levels show little difference, and none shows any stratigraphically demonstrable evolution in type. Among the presumably Late Neolithic stone implements of north China, however, are types like the Indian ones 2, 6, 8, and 9, which also occur in the sites of India, Indo-China, and Malaya. In addition, there are pecked celts similar to pecked specimens of the Indian types 2 and 3, which are lacking in Indo-China and Malaya. Also present are celts of type 5, which is missing in Indo-China but found on the surface in Malaya, and celts of type 10, which to date occurs only on the surface in southeast Asia. Other north Chinese celt forms not found in India include perforated celts of trapezoidal, rectangular, or square shapes, perforated stone battleaxes, and a waisted celt or hoe somewhat like that from Malaya.

There are several points of interest displayed by these north Chinese celts. One is that most of them are of types like the Indian ones believed to belong to intermediate or late dates. As the Chinese celts are of Late Neolithic date, this may be significant from the point of view of chronology. Another is that among the Late Neolithic north Chinese celts are varieties showing pecking, a technique of manufacture very rarely found in southeast Asia. This suggests that the pecking technique, and possibly certain celt forms connected with it, may have been introduced into India directly from China without reaching southeast Asia in large numbers. If this is true, the date of introduction was prior to that of the entry of the finely made celts of types 9 to 12, since pecked celts occur far beyond the limits of the former types. A third point is that celts of the rectangular type 10 also come from north China. The writer has found very few examples of this type in southeast Asia. A final point is that while the similarity of certain north Chinese celt forms with those in India suggests a cultural relationship of some kind, the fact that many north Chinese celts do not occur in India indicates that by Late Neolithic times the cultural connections were general rather than specific. Unfortunately, for lack of data it is impossible to determine how close the relationship may have been in earlier periods. Nevertheless, it does appear that the cultures of China, rather than southeast Asia, were responsible for the origin of the Indian celt types 5 and 10, regardless of the date at which they were first made.

Turning to south China one finds that the part of the country south of the Tsinling mountains is relatively unexplored and that few sites of any kind have been excavated there.

In the province of Kwangsi, near the borders of Indo-China, excavated caves have yielded archaeological material somewhat like that from Hoabinhian sites in Indo-China (Pei, 1935; Teilhard de Chardin and Pei, 1944; Teilhard de Chardin, Young, Pei, Chang, 1935). No Bacsonian or later type of complex has yet appeared here.

Outside of Kwangsi practically all study of Stone Age artifacts has to be done on a typological basis. The only place in which this has been done in detail is in the province of Szechwan. The stone implements from this province, most of them surface finds, have been exhaustively studied by Cheng Te-k'un and have been compared by him with stone tools from other parts of eastern Asia. The complete results of Cheng Te-k'un's work are contained in an unpublished doctoral thesis now in the archives of Harvard University. A summary of them appears elsewhere (Cheng Te-k'un, 1941, 1942, 1947).

After making a typological study something like the present one, Cheng Te-k'un suggests that there were four periods of stone implement evolution in Szechwan. These were (*a*) a Mesolithic period during which only chipped stone tools were used, (*b*) an Early Neolithic period characterized by implements partially smoothed near the cutting edge, (*c*) a Late Neolithic period in which the art of pecking stone was introduced, and (*d*) an Aeneolithic period during which implements were almost completely smoothed. Cheng Te-k'un also states that 34 of 41 chipped stone types, 6 of 11 chipped and partially smoothed ones, and 14 of 17 completely smoothed ones are the same in both Szechwan and Indo-China. He concludes, aside from the lack of pecked tools in Indo-China, that the major classes of stone artifacts probably appeared in Szechwan in the same chronological order as they are believed to have done in Indo-China. This may or may not be true, and proof or disproof of the statement will require years of future excavation. Nonetheless, it appears perfectly logical, in view of the increasing amount of evidence from Kwangsi and the whole of southeast Asia, that implements similar in so many respects to those of southeast Asia should have had a similar history.

If Cheng Te-k'un is correct, the stone industries of Szechwan should also be like those of India, where stonework seems to have evolved very nearly as in Indo-China. Thus, through the agency of the few stratified Indo-Chinese sites, one may equate the Late Stone Age culture complexes of Szechwan with those of India as follows:

Szechwan	*Indo-China*	*India*
Aeneolithic	Late Bacsonian, Somrong Sen	Late "Neolithic"
Late Neolithic	Late Hoabinhian, Mid-Bacsonian	Middle "Neolithic"
Early Neolithic	Mid-Hoabinhian, Early Bacsonian	Early "Neolithic"
Mesolithic	Early Hoabinhian	....

According to this scheme, Cheng Te-k'un's independent dating of pecked implements in Szechwan to an intermediate period would correspond to the present writer's dating of similar tools to a Middle "Neolithic" period. These tools, neither the earliest nor the latest of "Neolithic" celt types, may some day appear in southeast Asian complexes of about Mid-Bacsonian type. When found in Late Neolithic north Chinese horizons, they may be considered as survivals of earlier types. At present, pecked tools show a closer relationship between India and China at a certain period in prehistory than they do between either India or China and southeast Asia.

Specific information regarding the point of origin of the Indian celt types 7 and 12, which have not been positively identified from southeast Asian or north Chinese excavated remains, is not easy to find in south China. Celts of type 7 have been collected in some numbers in Yunnan in association with other characteristically Indian types such as 2, 3, 5, 8, and 9 (Anderson, 1871; Brown, 1909, 1914). They may therefore have originated somewhere in southwest China or Burma and have been brought to India at an intermediate date along with the small type 6 and its apparent contemporaries 5 and 8. No information about the origin of celt type 12 is forthcoming from south China at all.

With regard to China as a whole, it seems that during the early post-Pleistocene period the stone industries of the Ordos, Mongolia, and Manchuria differed considerably from those of Kwangsi in southernmost China. It would further appear that at a slightly later date the implement assemblages of southern China, southeast Asia, and the eastern half of India were very much alike. To what extent they also resembled those of northern China is not known until shortly prior to the date of the first known metal there. Specifically, however, there is some reason to believe that cultural connections involving the use of celt types 5, 7, and 10 were closer between China and India than between India and any other region.

DATING

The dates when smoothed stone implements were extensively used in India and eastern Asia are difficult to determine with the information now at hand, and only the most general statements regarding them can be made. As is already well known, stone celts were utilized well into the Metal Age in many parts of western, southern, and eastern Asia. In some instances, the periods of such use are established by historically datable archeological material. The latest dates at which celts were employed by purely Stone Age peoples, on the other hand, are harder to ascertain. The dates of their earliest use in Asia cannot be estimated with any degree of certainty.

In India, metal was apparently first employed in the Copper-Bronze Age cultures of the Indus River Valley between about 3000 and 1500 B.C. There is no indication that cultures of this type extended far east of the Indus basin at any time prior to 1500 B.C. Neither is any other kind of early Metal Age culture known to have existed in any part of eastern, central, or southern India. Therefore, the first Metal Age peoples to penetrate deeply into India were presumably the Indo-Aryan immigrants from the west, who established settlements in the Ganges river floodplain by about 1000 B.C. If this be true, Stone Age cultures could have existed in much of north India until the beginning of the first millennium B.C. Stone Age peoples may also have lived in southern India until approximately the fourth century B.C., when the first major contacts between the Indo-Aryans of the north and the aborigines of the south were apparently made.

In China, historical records of an advanced metal-using people are fairly well established as far back as the beginning of the Chou dynasty in 1122 B.C. The traditional dates of the next earlier Chinese dynasty, that of Shang, are recorded in later Chinese literature as 1766 to 1122 B.C. The only known archeological site of this period is that of Anyang, a capital city of the late Shang rulers in Honan province, which can be dated roughly from 1400 to 1100 B.C. Excavations at this site have uncovered many "oracle bones" (or bones used in divination) on which traces of a written script have been found. The script lists the names of sufficient kings of the Shang dynasty to prove that records of its traditional chronological position preceding that of Chou are essentially correct and that the dates of 1400 to 1100 B.C. given in later literature for the Shang occupation of Anyang are reasonably accurate. Excavations have also shown that the people of this period were well acquainted with bronze, though not with iron, and that they manufactured beautiful vessels and other objects of very superior workmanship. The date of the use of metal in north China may therefore be pushed back to about 1400 B.C. on fairly reliable evidence.

The technical excellence of the Shang bronzes and the strictly local character of their forms and decoration suggest either that the art of metal-working had undergone a long development in China prior to 1400 B.C. or that it had been introduced into that country in a highly evolved state and adapted to local use with considerable rapidity. Unfortunately, no early Shang remains dating from the period between 1700 and 1400 B.C. have been excavated, and there is no way of knowing whether or not the founders of the dynasty were responsible for the introduction of bronze-working into China. On the basis of present information, therefore, the date of the first use of metal in north China cannot be put earlier than 1400 B.C. Thus, Late Neolithic cultures may have lasted in that area until about the middle of the second millennium B.C.

There is no evidence of metal-working in south China prior to the beginning of the Metal Age in the north. One may therefore assume that Stone Age cultures existed in south China until some time after 1400 B.C.

The earliest sites in southeast Asia which contain metal objects date from about the fourth or third centuries B.C. to the first century A.D., during part of which time Indo-China was under the control of the Chinese Han Empire. At approximately the same time, iron may have been introduced to the coastal portions of southeast Asia from India. By these dates, both bronze and iron were regularly employed in north China and India, and most peoples of those countries had long since passed out of the Stone Age. Thus, metal was apparently brought to southeast Asia considerably later than it was to the countries to the north and west. Stone tools may therefore have been extensively utilized in the marginal regions of Indo-China, Siam, and Malaya until the beginning of the Christian era or later.

The next earlier dates which it is possible to estimate are those of the first rectangular-sectioned stone celts made by the Indian technique II. Information regarding them is derived almost wholly from north China, however, and it can not be considered as trustworthy as that given above.

A number of archeologists have noted the similarities between designs painted on Late Neolithic pottery in northwest China and those found on pottery in Early Metal Age sites in the Middle East. In addition, they have pointed out a few striking likenesses in the form, color, and texture of some Lungshan plain wares and certain Metal Age Middle Eastern ones. On the basis of these data, it has been claimed that Late Neolithic north Chinese cultures are both related to and descended from the Middle Eastern ones in which the above characteristics appear. Whether or not the points of similarity constitute valid evidence of cultural relationship has not yet been fully decided. Nevertheless, it is true that painting on pottery is primarily a Middle Eastern rather than a Far Eastern trait, and it may be that the Late Neolithic complexes of north China represent the easternmost expansion of a widespread series of Middle Eastern ones. If this is true, the earliest dates of the north Chinese painted pottery and gray-black pottery complexes cannot well be before 3000 B.C., the time at which their Middle Eastern parallels appeared. Indeed, these complexes may well be considerably later, and they may have lasted till Shang times.

The Late Neolithic cultures of north China are the earliest more or less datable ones in eastern Asia in which celts of the types 9 through 12 appear. If they were derived from the west, their influence at least in the form of stone-working techniques probably spread eastward and southward until it reached southeast Asia and India. There is no way of discovering exactly how long it may have taken for this to occur. However, if the art of metal-working took almost 1500 years to reach southeast Asia from the points of its introduction into India and China, it may have taken an equal period of time for the Late Neolithic stone implement types to penetrate into Indo-China and Malaya. This is pure speculation, of course. Still, since the spread of metal was undoubtedly as rapid as that of stone implements, it may not be far from the truth. It is therefore possible that sites in India and southeastern Asia in which celts of types 9 to 12 are found should not be dated earlier than 1500 B.C. at the earliest. The limited distribution of rectangular-sectioned celts in India, coupled with the fact that these types frequently occur only in the topmost few inches of archeological sites or upon the ground surface throughout southeast Asia, strongly suggests that they were late arrivals in those regions.

The dating of the earliest smoothed stone implements in eastern Asia is also something of a problem. If the late Neolithic culture complexes of north China were related to Bronze Age ones in the Middle East, and if they spread into China from the west, there is a possibility that they were superimposed upon a series of still earlier Neolithic complexes already existing in eastern Asia. The following data suggest that something like this actually happened. The earliest archeological sites throughout the Far East in which Neolithic traits have been found are characterized not by painted pottery of west Asiatic types but by unpainted, cord-marked, textile marked, mat-marked, or incised and indented wares. These wares occur from Lake Baikal in eastern Siberia to Indonesia and from eastern China to Kashmir State in north India. They may also be related to the cord-marked and comb-marked potteries which made their way into central and northern Europe with Neolithic peoples. Wares of these types are present in Kashmir State, Burma, southern Siam, Indo-China and Malaya. Similar pottery also occurs in considerable quantity even with the painted and gray-black wares of Kansu, Yang Shao, and Lungshan in north China. It is completely foreign to the Neolithic and Metal Age cultures of the Middle East and the Mediterranean world. Along with other objects found only in the Neolithic and quasi-Neolithic sites of eastern Asia, it serves to point out the basic differences in cultural tradition between the eastern and western portions of the continent. It therefore seems that any late, west Asiatic Neolithic cultural influences reaching China actually did intrude into a large east Asian area in which at least one of the four basic Neolithic traits was commonly represented. Because of the paucity of Early Neolithic finds in northern China, one cannot make the same statement with regard to smoothed stone tools. Still, in south China, southeast Asia, and India a number of stone celt types have a wider or earlier distribution than those found in the Late Neolithic north Chinese complexes. It is therefore possible that these apparently early celt types were also in use in north China before Late Neolithic times.

The wide distribution of the east Asiatic potteries and early types of stone tools far beyond the limits reached by the western painted pottery and rectangular-sectioned celts indicates that the origin and earliest expansion of the cultures utilizing the former should be placed before 3000 B.C. It may be that they date from as early as 5000 or 4000 B.C. though proof for any such assumption is still lacking. If they did spread into northwest China from west or central Asian centers of origin, however, and if the 1500-year time lag postulated in previous cases may again be used here, the earliest Neolithic traits may not have reached peninsular India and southeast Asia till 3500 or 2500 B.C. Granted, this last is a time when copper and bronze were already known throughout the Middle East and the Indus valley in India. Nevertheless, the distribution of stone celts mainly in the eastern half of India, together with the lack of proof that Neolithic traits spread into the peninsula from the west, strongly indicates that these celts could not easily have reached India at a very early date. The dates mentioned may therefore be reasonably accurate. They are certainly no later than those of the first Neolithic remains in northern and western Europe.

In summary, then, the earliest Neolithic-like stone tools probably appeared in India not earlier than 3500 or 2500 B.C. They remained in general use in northeastern India at least until the introduction of the late celt types 9 through 12 at about 1500 B.C. In peninsular India they may have been employed till the fourth century B.C. Celt types 9 to 12, first made in India around 1500 B.C., were apparently still spreading westward when they were supplanted by metal implements brought into the Ganges river basin by the Indo-Aryan immigrants from the west at approximately 1000 B.C. They never reached the southern part of the country.

CONCLUSIONS

As a result of the above study, one can draw the following conclusions:

(*a*) In India itself there is no positive archeological proof for the existence of Neolithic peoples at any time before or after the use of metal was introduced into that country.

(*b*) On the basis of their typology and distribution, Indian smoothed stone celts of "Neolithic" type, regardless of their cultural affiliations, appear to be derived from the eastward. Chronologically, they seem to have been introduced into the country at different dates.

(*c*) A typological comparison of Indian and Far Eastern celt types corroborates the above postulate of typological relationships and supports the theory that certain Indian types are earlier in date than others.

(*d*) Since most southeast Asian stone celts which are similar to Indian ones occur in archeological associations with genuine Stone Age characteristics, most Indian celts probably also belong to Stone Age cultures very much like those of southeast Asia.

(*e*) If the above is true, the eastern half of India belonged to a fairly large south and east Asiatic area throughout which the evolution of post-Pleistocene prehistoric cultures was apparently more or less similar. In the early periods, this area seems to have included much of India, Burma, southeast Asia, and southern China. In the later ones, it was apparently confined in the west to the easternmost provinces of India but expanded in the east to include parts of north as well as south China.

Other evidence supplied by geography, zoology, botany, and archeology further supports the theory of long-standing cultural relationship in the area embracing India, southeast Asia, and south China, but it cannot be considered here.

(*f*) Unfortunately, in spite of the strong suggestion that many Indian "Neolithic" artifacts really belonged to Stone Age cultures, there is still no indication from any part of southern and eastern Asia that these cultures were Neolithic ones. Archeological excavation and publication in India and the Far East has, for the most part, been so casual that no records of domesticated plants or animals exist outside of north China even though such remains may actually have occurred at excavated sites. In spite of the argument that the wet climates of monsoon Asia do not favor the preservation of plant remains, it is not beyond the bounds of possibility that careful excavation will uncover them in the dry earth of caves and rock shelters. Neither is it impossible that a proper examination and identification of excavated animal bones will produce the proof that some of the species were domesticated. In fact, there seems a definite chance that evidence for food-producing could be found.

Confirmation of the nature of Indian and other Far Eastern celt-using cultures, however, depends primarily upon the archeology of the future rather than the past. Typological studies such as the present one, based on incomplete information, are of value only in suggesting the existence of cultural movements or relationships. They cannot in themselves be accepted as final, and this writer in no way considers his conclusions proven. It is therefore to be hoped that intelligently planned programs of archeological investigation will be instituted or continued in India and elsewhere in order that the problems of prehistory in those regions may be solved.

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PALEONTOLOGY.—Two new genera of brachiopods from the Henryhouse formation (Silurian) of Oklahoma.[1]

THOMAS W. AMSDEN, The Johns Hopkins University. (Communicated by ALFRED R. LOEBLICH, JR.)

The writer has recently made a study of the brachiopods from the Henryhouse formation that has resulted in the recognition of two new genera. The complete faunal study will be published in about a year, but since Dr. Alwyn Williams wishes to refer to one of these genera in a paper soon to be forthcoming, it seems advisable at this time to publish a description of the new genera and their genotypes.

The specimens studied are located at the U. S. National Museum and were made available through the courtesy of Dr. G. A. Cooper and Dr. A. R. Loeblich. The writer also wishes to acknowledge the help of Dr. Cooper who gave suggestions and criticisms throughout this study.

Lissostrophia, n. gen.

Description.—Shells belonging to this genus are small with a subtriangular to subcircular outline; the hinge line is straight and forms the greatest width of the shell. In lateral profile it is strongly concavo-convex with the brachial and pedicle valves fairly close together; the curvature of both valves is uniform, there being no fold or sulcus. The pedicle beak is small and the palintrope of both valves is well developed, that of the pedicle being slightly wider than the brachial. The surface of both valves is completely smooth except that some shells may show faint, concentric growth lines.

In the pedicle interior the diductor scars are moderately deep, elongated subparallel to one another, and separated by an elevated platform to which the adductors were presumably attached. The hinge-plate is denticulate for one-half to two-thirds its length; the delthyrium usually appears as a rather shallow notch in this plate and in some specimens it is represented by only a very slight indentation.

The brachial interior is marked by a conspicuous elongate cardinal process which is directed posteriorly at right angles to the hinge line. The posterior half of this cardinal process is divided into two lobes which are subparallel to one another. Two thick ridges extend out from the base of the cardinal process in an anteriolateral direction. In addition, there are two relatively broad median ridges which extend from about the center of the valve almost to the base of the cardinal process. At the posterior end these are separated by a low median platform which extends in an anterior direction until it attains approximately two-thirds the distance from beak to border. In the central portion these two median ridges are separated by a valley but at their posterior end they are again separated from one another by a low ridge which is a continuation of base of the cardinal process. The brachial hinge plate is strongly denticulate for a part of its length.

Genotype, *Lissostrophia cooperi*, n. sp.

Discussion.—This genus is somewhat similar to *Pholidostrophia* (Hall and Clark, 1892, p. 287) in size, shape, and lack of ornamentation, but it is not nacreous. Internally it differs from that genus in that the diductor scars of the pedicle valve are narrow and subparallel, whereas in *Pholidostrophia* they are broader and semiflabellate. In the brachial interior the cardinal process of *Lissostrophia* is more erect and extends farther beyond the hinge line than does that of *Pholidostrophia;* furthermore, the two median ridges are much better developed in *Lissostrophia.*

This genus differs from *Brachyprion* (Shaler 1865, p. 63; Caster 1939, p. 31, 33) and related genera in its complete lack of radial ornamentation. Also in the pedicle interior of *Brachyprion* the muscle scars are flabellate.

Lissostrophia cooperi, n. sp.

Description.—The shell is small and subcircular in outline. Its hinge line is straight with the lateral extremities produced into points. The width is about equal to the length with some specimens being slightly wider than long and others slightly longer than wide. It is deeply concavo-convex with the brachial valve rather closely following the pedicle to produce a shallow living chamber. The surface is completely smooth except for faint, irregularly spaced growth lines. A specimen of average size will measure about 6 mm. wide, 5.5 mm. long, and 3 mm. deep.

Discussion.—This is probably the species that Reeds (1911, p. 263) called *Pholidostrophia* sp.

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[1] Received April 28, 1949.

This species is named for Dr. G. A. Cooper.

Holotype, U.S.N.M. no. 115194.

Distribution.—This is a common species in the Henryhouse. Holotype from the Cen. NE¼SW¼ sec. 10, T. 2 N., R.6 E., Pontotoc County, Okla.

Nanospira, n. gen.

Description.—The only known species of this genus is the genotype, which has an extremely small, subcircular shell. It has a strongly convex pedicle valve and a brachial valve which is flattish to slightly concave. The pedicle valve has a smooth, even curvature and a small, pointed beak. There is a brachial sinus which is narrow and distinct on the posterior portion of the valve becoming broad towards the anterior end. The exterior of both valves is completely smooth except for concentric growth lines.

In the pedicle interior the teeth are prominent and attached directly to the wall of the valve. There is a median septum or platform which extends for about one-half the length of the valve and which is V-shaped in cross section. This begins as a low ridge at the posterior end but becomes increasingly broader and higher towards the central part of the valve; its anterior end is slightly excavated and the sides are produced forward for a short distance as low ridges.

The brachidium of this genus is rather unusual and the writer is indebted to Dr. G. A. Cooper for preparing specimens to show this structure. The spire is abbreviated, consisting of less than one volution with the apices medially directed. The jugum is unusual in that each of its branches comes off from the anterior portion of the spires; these continue posteriorly as separate structures which are outside of and parallel to the main branches of the spires. Near the posterior end of the valve they cross over the descending lamellae and turn forward before uniting. The spire appears to be strongly spinose.

This genus has a smooth exterior like that of *Glassia* (Davidson 1881, p. 11). The spires of *Nanospira* are directed as they are in *Glassia* but have many less coils; the jugum is different, originating much further forward than in *Glassia*. Also *Glassia* appears to lack the strong median platform which is present in the pedicle valve of *Nanospira*. *Protozyga* (Hall and Clarke 1894, p. 151) has a simple spire like that of *Nanospira* but differs in the nature of its jugum and in having dental plates in the pedicle valve. *Cyclospira* (Hall and Clarke 1894, p. 146) differs in its biconvex profile and strong ventral sulcus. The jugum of *Cyclospira* is unknown.

Genotype, *Nanospira parvula*, n. sp.

Nanospira parvula, n. sp.

Description.—This species has a very small shell with the width about equal to the length and a short hinge line. It has a strongly convex pedicle valve and a weakly convex to weakly concave brachial valve. The pedicle beak is small and strongly curved over the dorsal but not in conjunction with it; along the mid-line of the pedicle valve the curvature is sharp with the shell sloping uniformly away from here to the lateral and anterior margins. There is a brachial sulcus which is narrow at the posterior end but which becomes broad at the anterior end; on the posterior half of the brachial valve where this sulcus is narrow and confined to the mid-line this valve retains a slight convexity but toward the anterior end where it broadens out so that it occupies almost the entire width of the shell this part of the valve becomes slightly concave. The surface is completely smooth except for growth lines, these being best developed on the anterior half of the shell. A specimen of average size measures about 3.5 mm. long, 3.5 mm. wide and 2 mm. thick. The brachial and pedicle interiors have already been described.

Discussion.—*N. parvula* is the only known representative of this genus and has been identified only from the Henryhouse formation.

Holotype, U.S.N.M. no. 115195.

Distribution.—Specimens of this species are common in the Henryhouse. Holotype from Chimneyhill Creek in Cen. E½SE¼SW¼, sec. 4, T. 2 N., R. 6 E., Pontotoc County, Okla.

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ENTOMOLOGY.—*The status of the genus* Mymar *Curtis* (Hymenoptera: Mymaridae).[1]

A. B. GAHAN, U. S. Bureau of Entomology and Plant Quarantine. (Communicated by C. F. W. MUESEBECK.)

The genus *Mymar* has been discussed by Hincks (Proc. Roy. Ent. Soc. London **13:** 38. 1944) and by Soyka (Zentbl. für Gesamtgeb. Ent., Jahrg. 1 (5–6): 180. 1946). Unfortunately I cannot agree with either author.

In the list of type species of the genera of chalcid-flies by Gahan and Fagan (U. S. Nat. Mus. Bull. 124: 92. 1923), *Mymar* Curtis and *Anaphes* Haliday were stated to be isogenotypic, both having as genotype *Ichneumon punctum* Shaw. *Anaphes*, being the later proposed name, was indicated as a synonym of *Mymar*. The reasons for this conclusion were not there discussed, as they were considered to be rather self-evident to anyone who cared to investigate. Neither Hincks nor Soyka agrees with these conclusions, nor do they agree with each other. It therefore seems desirable to state the facts upon which this synonymy was based. These are as follows:

The generic name *Mymar* was first published without description by John Curtis in 1829 (Guide to Brit. Ins.: 112) and credited by him to Haliday. Eighteen specific names were included under the generic name, most of these being manuscript names of Curtis, Walker, Haliday, and Stephens, but names of three previously described and valid species were also included, viz, *Ichneumon punctum* Shaw, *I. ovulorum* Linnaeus, and *I. atomos* Linnaeus. This publication of the generic name *Mymar* in connection with valid species established the name and made eligible for type of the genus any one of the three described species mentioned. None of the 15 manuscript species included can be considered eligible for designation as type. Among the latter was the Walker manuscript name *pulchellus*.

In 1832 Curtis (Brit. Ent. **9:** 411) published a description of *Mymar*, naming as type of the genus *Ichneumon punctum* Shaw. Although naming *punctum* as the genotype, Curtis figured and described only *Mymar pulchellus*, Walker manuscript, and at the end of the generic description stated that "the dissections and descriptions are taken from the species figured." It is evident from the generic description, however, that Curtis took care to make it broad enough to include *punctum* as well as *pulchellus*.

In 1833 Haliday (Ent. Mag. **1:** 349) redescribed *Mymar* as his own genus but cited Curtis's previous references. Haliday included in *Mymar* the single species *pulchellus*. At the same time (p. 346) he erected the genus *Anaphes* with two included species, one being *Ichneumon punctum* Shaw and the other *Anaphes fuscipennis* Haliday. He made no reference to genotypes.

In 1840 Westwood (Introd. Mod. Class. Ins. **2:** Synop.: 78), ignoring the previous designation by Curtis of *Ichneumon punctum* Shaw as type of the genus *Mymar*, named *Mymar pulchellus* Curtis as the type of *Mymar* and *Ichneumon punctum* as the type of *Anaphes*.

Ashmead in 1904 (Mem. Carnegie Mus. **1:** 363) cited *Mymar pulchellus* Curtis as type of *Mymar* but named *Anaphes fuscipennis* Haliday as type of *Anaphes*. Since *Ichneumon punctum* had already been designated as type of *Anaphes*, Ashmead's designation must be ignored.

From the foregoing statements the following facts are apparent.

1. *Mymar*, as a generic name, must be credited to Curtis and must date from 1829, since it was there published with inclusion of valid species.
2. *Ichneumon punctum* Shaw must be accepted as the genotype of *Mymar*, since it was one of the originally included species and was legitimately designated as the genotype by Curtis in 1832, thus having priority over the designation of *pulchellus* by Westwood in 1840.
3. *Ichneumon punctum* Shaw was originally included in *Anaphes* and was legitimately chosen as type of that genus by Westwood.

Soyka's conclusions likewise are un-

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[1] Received March 15, 1949.

tenable, at least in part. This author proposes the new generic name *Ogloblinieila* and names as genotype *Mymar pulchellus* Curtis. If *pulchellus* is congeneric with *wollastonii*, as I believe it to be, then *Ogloblinieila* Soyka is a synonym of *Mymarilla* Westwood. If the two species should prove not to be congeneric (and on the basis of Westwood's figures there is ground for doubt), then *Ogloblinieila* should stand. Until this question can be cleared up, I prefer to use *Mymarilla* with *Ogloblinieila* as a synonym. Soyka's action in attempting to name for the genus *Mymar* Curtis an entirely new genotype (viz, *Mymar ferrierei* Soyka) is entirely unacceptable since the species was not an originally included one and the genus already had a legitimately fixed type.

Since *Ichneumon punctum* is the type species of both *Mymar* Curtis and *Anaphes* Haliday, it follows that the name *Anaphes* must fall as a synonym of *Mymar*. This is unfortunate since it necessitates the realignment of the generic and specific combinations for a considerable number of species, but I can see no way to avoid this except by a complete disregard of the Rules of the International Commission on Nomenclature. The generic name *Mymar* must be used in the sense of *Anaphes* Haliday and authors, and all the species now known and catalogued in *Anaphes* should henceforth take the name *Mymar*. At the same time all the species heretofore placed in the genus *Mymar* must be known by a different generic name, and for this purpose *Mymarilla* Westwood (Trans. Linn. Soc. London, Zool., **1** (ser. 2): 585, footnote. 1878), with *M. wollastonii* Westwood as its genotype is resurrected from the synomymy. It is possible that *Flabrinus* Rondani (Bul. Soc. Ent. Ital. **9**: 180. 1877) may be the same as *Mymarilla*, but it seems extremely doubtful that this genus can ever be satisfactorily identified.

The conclusions by Hincks in the paper already mentioned are contrary to those arrived at in the foregoing remarks. In my opinion they do not conform to the International Rules of Nomenclature, and hence are untenable.

MAMMALOGY.—*A new name for the meadow mouse* Microtus roberti occidentalis *Turov*.[1] DONALD F. HOFFMEISTER, University of Illinois (Communicated by HERBERT FRIEDMANN.)

When Prof. S. S. Turov described *Microtus roberti occidentalis* in 1928, he undoubtedly was unaware of the earlier (1848) description by Peale of *Arvicola* [= *Microtus*] *occidentalis*. Peale's name is now regarded as a synonym of *Microtus townsendii townsendii* (Bachman, 1839). Efforts have been made over a period of years to contact Professor Turov and bring this fact to his attention for rectification. In the absence of any word from Turov or any known action that he has taken, it seems advisable now to make the required changes.

Turov regarded the species *roberti* as belonging to the genus *Microtus*. Some other workers have regarded *roberti* as a member of a distinct genus *Chionomys*. However, Miller (Ann. Mag. Nat. Hist. **8**: 97. 1908) and Argyropulo (Zeitschr. für Saugetierk. **8**: 182. 1933) presented rather conclusive evidence that *Chionomys* should be regarded as a subgenus of *Microtus*. In reviewing the problem, Ellerman goes farther by regarding *Chionomys* a synonym of the subgenus *Microtus* and places *Microtus roberti* in a species-group other than that of the type (*Microtus nivalis*) of *Chionomys* (see Ellerman, *Families and genera of living rodents*, British Mus. Nat. Hist., **2**: 592. 1941).

The subspecies *occidentalis* of Turov is here regarded as a member of the genus *Microtus* and its name thus is preoccupied by *Microtus occidentalis* Peale. This subspecies may now be known as:

Microtus roberti turovi, n. name

Microtus roberti occidentalis Turov, Arb. Nord-Kaukasischen Assoc. Wiss. Inst., no. 44–45: 27. 1928; *nec Arvicola* [= *Microtus*] *occidentalis* Peale, U.S. Expl. Exped., Mamm. and Ornith.: 45. 1848 (type from Puget Sound, Wash.).

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[1] Received March 17, 1949.

Type.—No. 21K., ♀, August 25, 1926, on the shore of Lake Kardivach [in rhododendron overgrowth], Mzimite River, Caucasus [U.S.S.R.] (translated from Turov, p. 27).

Turov, on page 29, *op. cit.*, adds that three "other examples [were] caught 2–3 versts below Kardivach on the banks of the Mzimite River in rocky places overgrown with silver fir forest."

PROCEEDINGS OF THE ACADEMY

51ST ANNUAL MEETING

The 51st Annual Meeting, concurrently with the 361st meeting of the Academy, was held as a dinner meeting in the ballroom of the Hotel 2400, January 22, 1949, at 5:30 P.M., with the President, FREDERICK D. ROSSINI, presiding.

Following the dinner, the guest speaker, W. Alfred Noyes, talked on *International cooperation in science.* Greetings to the Academy were extended by FRED E. WRIGHT, home secretary of the National Academy of Sciences, and S. S. NEGUS, president of the Virginia Academy of Science.

The minutes of the 50th Annual Meeting were approved as published in the JOURNAL **38:** 213–222. 1948.

The reports of several officers, standing committees, special committees, and committees of auditors and tellers were read and accepted. The pertinent reports are recorded at the end of the minutes.

After acceptance of the report of the Committee of Tellers, the President declared the following duly elected to the given offices:

FRANK H. H. ROBERTS, Jr., *President*
FRANCIS B. SILSBEE, *President-Elect*
FRANK M. SETZLER, *Secretary*
HOWARD S. RAPPLEYE, *Treasurer*
WILLIAM F. FOSHAG and C. LEWIS GAZIN, *Board of Managers to January, 1952.*

The Secretary presented for the Affiliated Societies their nominations for Vice-Presidents of the Academy as follows:

Philosophical Society of Washington—FRANCIS E. JOHNSTON
Anthropological Society of Washington—WILLIAM N. FENTON
Biological Society of Washington—JOHN W. ALDRICH
Chemical Society of Washington—FREDERICK D. ROSSINI
Entomological Society of Washington—C. F. W. MUESEBECK
National Geographic Society—ALEXANDER WETMORE
Geological Society of Washington—JOHN B. REESIDE, JR.
Medical Society of the District of Columbia—FREDERICK O. COE
Columbia Historical Society—GILBERT GROSVENOR
Botanical Society of Washington—FREEMAN A. WEISS
Washington Section of the Society of American Foresters—WILLIAM A. DAYTON
Washington Society of Engineers—CLIFFORD A. BETTS
Washington Section of the American Institute of Electrical Engineers—FRANCIS B. SILSBEE
Washington Section of the American Society of Mechanical Engineers—RICHARD S. DILL
Helminthological Society of Washington—AUREL O. FOSTER
Washington Branch of the Society of American Bacteriologists—MARGARET PITTMAN
Washington Post of the Society of American Military Engineers—HENRY W. HEMPLE
Washington Section of the Institute of Radio Engineers—HERBERT G. DORSEY
Washington Section of the American Society of Civil Engineers—OWEN B. FRENCH

The Secretary was instructed by the members present to cast a unanimous ballot for these nominees.

The chairman of the General Committee on Awards for Scientific Achievement, KARL F. HERZFELDT, announced the recipients of these awards for 1948 as follows:

In the Biological Sciences, ROBERT J. HUEBNER, National Institutes of Health, in recognition of contributions to our knowledge of the transmission of certain rickettsial diseases.

In the Engineering Sciences, MAXWELL K. GOLDSTEIN, Office of Naval Research, in recognition of distinguished research and development in the field of electronic engineering.

In the Physical Sciences, J. A. VAN ALLEN, Applied Physics Laboratory of Johns Hopkins University, in recognition of his work in nuclear physics and cosmic rays.

The retiring President, FREDERICK D. ROSSINI, gave a short talk and introduced the incoming President, FRANK H. H. ROBERTS, Jr. Dr. Roberts adjourned the meeting at 9:00 P.M.

REPORT OF THE SECRETARY

During the Academy year, January 15, 1948, to January 22, 1949, one person was elected to honorary membership and 73 to regular membership, including 70 to resident and 3 to nonresident. Of these, 55 resident and 2 nonresident qualified for membership. Fourteen resident members and one nonresident member elected to membership in the preceding Academy year qualified during the present Academy year just ending. The new members were distributed among the various sciences as follows: 13 in chemistry, 11 in medicine, 10 in physics, 6 each in botany and entomology, 4 each in engineering and mathematics, 3 each in geophysics and plant pathology, 2 each in biochemistry, electrical engineering, paleontology, and zoology, and 1 each in biology, endocrinology, ethnology, physiology, and science history.

Seven resident and three nonresident members, having retired from the gainful practice of their professions, were placed on the retired list of members to enjoy all the privileges of active membership without further payment of dues. Nine resident members and one nonresident member resigned in good standing. Four resident and six nonresident members were dropped for nonpayment of dues.

The deaths of the following members were reported to the Secretary:

William R. Maxon, Washington, D. C., on February 25, 1948.
Nelson H. Darton, Washington, D. C., on February 28, 1948.
Albert F. Woods, Hyattsville, Md., on April 12, 1948.
Albert K. Fisher, Washington, D. C., on June 12, 1948.
Oscar E. Meinzer, Washington, D. C., on June 14, 1948.
Harold W. Murray, Washington, D. C., on June 15, 1948.
Harry Diamond, Washington, D. C., on June 21, 1948.
François E. Matthes, El Cerrito, Calif., on June 21, 1948.
Ernest C. Andrews, Sydney, Australia, on July 1, 1948.
Richard C. Tolman, Pasadena, Calif., on September 5, 1948.
Louis Cohen, Arlington, Va., on September 28, 1948.
Joseph A. Ambler, New Orleans, La., on October 6, 1948.
Horace T. Herrick, Washington, D. C., on October 7, 1948.
William H. Emmons, Minneapolis, Minn., on November 5, 1948.

Ernest C. Andrews and Albert K. Fisher were honorary members, and Nelson H. Darton Albert F. Woods, and Albert K. Fisher were original members.

On January 22, 1949, the status of membership was as follows:

	Regular	*Retired*	*Honorary*	*Patron*	*Total*
Resident	498	55	2	0	555
Nonresident	155	30	14	0	199
Total	653	85	16	0	754

The net changes in membership during the past year are as follows:

	Regular	*Retired*	*Honorary*	*Patron*	*Total*
Resident	+41	+3	0	0	+44
Nonresident	−6	+4	−1	0	−3
Total	+35	+7	−1	0	+41

During the Academy year 1948 the Board of Managers held 10 meetings, with an average attendance of 19 persons. The following important matters were considered by the Board:

1. *Publication of a Monograph.* The monograph entitled *The parasitic cuckoos of Africa*, by Herbert Friedmann, was accepted for publication by the Board of Managers, and the Committee on Monographs was authorized to secure bids and arrange for its printing.

2. *Index to the Journal.* One of the recommendations made by a committee appointed last year to "Consider Various Matters Pertaining to the Journal and its Improvement" was that the Academy publish an index to the first 40 volumes of the Journal. This year a committee was appointed to further investigate the matter of an index. They looked into costs of compilation, means of publication, and prospective sale, reporting their finds to the Board. The Board decided to go ahead with the preparation of copy, allowing a period of three years for its compilation, but deferred the matter of its publication until some future time, looking forward to the possibility of an outside grant to cover part or all of its publication cost.

3. *Changes in the Bylaws.* The Board of Managers recommended and the membership of the Academy approved three changes in the Bylaws: (1) The permitted number of regular members was increased 100, allowing a total of 750 for both resident and nonresident. The permitted number of resident regular members was increased to 600. (2) The office of President-elect was created to promote continuity of policies

and objectives of the Academy by acquainting the incoming president with the current business and the administrative routine of the Academy. (3) A new Article I was written to incorporate into the Bylaws a statement of purposes and objectives not previously included.

4. *New Standing Committees.* The Standing Rules for the Board of Managers were amended to provide for and define the activities of 4 new Standing Committees. Two of these, the Committee on Awards for Scientific Achievement and the Committee on Grants-in-Aid for Research, had been activated by the Board of Managers some years earlier but had not been defined by the Standing Rules. The two new committees created during the past year are the Committee on Policy and Planning and the Committee on the Encouragement of Science Talent. The Committee on Policy and Planning was activated for the purpose of periodically assessing the status of the Academy from a point of view of long-term objectives and recommending to the Board any changes in policy or in long-range planning designed to make the Academy more effective in the scientific life of Washington. The Committee on the Encouragement of Science Talent was created to give consideration to, and make arrangements for, participation of the Washington Academy of Sciences in activities promoting a professional interest in science among people of high school and college age.

During the Academy year, nine meetings of the Academy were held as follows:

On February 19, 1948, the 50th Anniversary Meeting was given over to a smoker with light refreshments.

On March 18, 1948, the 1947 Academy Awards were presented to Harry W. Wells, Department of Terrestrial Magnetism, Carnegie Institution of Washington, for work in engineering sciences; and to Robert D. Huntoon, National Bureau of Standards, for work in the physical sciences. The subcommittee for the biological sciences failed to recommend an awardee.

On April 15, 1948, Philipp Frank, Harvard University, addressed the Academy on *Philosophical interpretations of physical theories.*

On May 20, 1948, Edward U. Condon, National Bureau of Standards, addressed the Academy on *Science and security.*

On October 21, 1948, substituting for Merriam H. Trytten, Alexander Wetmore, Smithsonian Institution, spoke to the Academy on the work of the Interdepartmental Committee on Scientific Research and Development; C. J. Lapp, Office of Scientific Personnel, spoke on *Baccalaureate origins of doctorates in scientific work;* and B. D. Van Evera, George Washington University, spoke on the fellowship program of the National Research Council.

On November 18, 1948, Robert F. Bacher, Atomic Energy Commission, addressed the Academy on *Research and development of atomic energy.*

On December 16, 1948, the meeting was devoted to a symposium on cancer research: Roscoe R. Spencer, National Cancer Institute, spoke on *Causes;* Harold F. Dorn, National Cancer Institute, spoke on *Incidence and distribution;* and Walter S. Harrison, U. S. Naval Hospital, spoke on *Detection and treatment.*

On January 3, 1949, Hans Cloos, University of Bonn, Germany, addressed a joint meeting of the Academy and the Geological Society of Washington on *Geologic structures through the ages.*

On January 22, 1949, W. Albert Noyes, University of Rochester, gave an after-dinner talk to the Academy on *International cooperation in science.*

All meetings, except that of January 3, were held in the Assembly Hall of the Cosmos Club. The Joint Meeting with the Geological Society of Washington on January 3 was held in the Department of the Interior Auditorium.

C. L. Gazin, *Secretary.*

REPORT OF THE TREASURER

The Treasurer submits the following report concerning the finances of the Washington Academy of Sciences for the year ended December 31, 1948.

RECEIPTS

Dues,	1942	$5.00	
	1943	10.00	
	1944	15.00	
	1945	30.00	
	1946	60.00	
	1947	142.00	
	1948	3,405.75	
	1949	59.00	$3,726.75
Journal, Subscriptions,	1947	30.19	
	1948	798.48	
	1949	602.82	
	1950	10.13	1,441.62

Reprints,	1947	229.03	
	1948	587.35	816.38
Sales,	1948		176.90
Interest & Dividends, 1948			968.50
Directory, 33d edition			98.60
Science Calendar			40.00
Total receipts, 1948			$7,268.75
Cash balance, Jan. 1, 1948			4,343.50
Total to be accounted for			$11,612.25

DISBURSEMENTS

	1947	1948	*Total*
Secretary's Office	$161.96	$341.62	$503.58
Treasurer's Office		247.01	247.01
Subscr. Mgr. & Custodian		45.86	45.86
Meetings Committee	221.18	449.35	670.53
Membership Committee		7.89	7.89
Journal			
Printing & mailing	379.87	3,520.28	3,900.15
Illustrations	16.51	442.82	459.33
Reprints	73.76	439.79	513.55
Office			
Editorial Asst.	25.00	275.00	300.00
Miscellaneous	9.23	33.12	42.35
Directory—33d edition		3,234.55	3,234.55
Miscellaneous:			
Debit Memos (A. S. & T. Co.) . . $19.06			
Refunds Dues 5.00			
Refunds Photos . . . 10.00			
Science Calendar 62.10			
Back numbers of Journal . . 21.85		118.01	118.01
	$887.51	$9,155.30	$10,042.81
Cash book balance, December 31, 1948			1,569.44
Total accounted for			$11,612.25

RECONCILIATION OF BANK BALANCE

Balance as per cash book, Dec. 31, 1948		$1,569.44
Balance as per Am. Sec. & Trust Co. Statement of Dec. 1, 1948	$1,517.09	
Receipts undeposited, Dec. 31, 1948	371.38	
Total	$1,888.47	

Checks outstanding, as of Dec. 31, 1948

No. 1018	$5.41		
1263	5.00		
1269	28.57		
1270	50.00		
1271	41.95		
1272	171.35		
1273	16.75	319.03	$1,569.44

INVESTMENTS

Washington Sanitary Improvement Company

Certificate No. A 182—818 shares at $10	$8,180.00	
Note: Replaces Certificates Nos. 434, 435, 527, 539, and 582 totaling 409 shares, surrendered prior to issuance of new stock, June 21, 1948		$8,180.00

Potomac Electric Power Company

Certificate No. TAO 1977—40 shares 3.6% pref. at $50.00	2,000.00

City of New York—3% (Transit Unification) Due June 1, 1980

Certificate No:		
D 20186	$500.00	
C 71038	100.00	
C 71039	100.00	
C 71040	100.00	800.00

First Federal Savings & Loan Ass'n

Investment account book	5,000.00

Northwestern Fed. Savings & Loan Ass'n

Certificate No.:		
1380	4,500.00	
1441	500.00	5,000.00

United States Government

Series G. Bonds:		
No. M 332990 G	$1,000.00	
M 332991 G	1,000.00	
M 332992 G	1,000.00	
M 332993 G	1,000.00	
M 1808741 G	1,000.00	
M 2226088 G	1,000.00	
M 2982748 G	1,000.00	
M 4126041 G	1,000.00	
M 5141346 G	1,000.00	
M 5141347 G	1,000.00	$10,000.00

American Security and Trust Co.	
Savings Account	46.87
Total	$31,026.87
Cash balance Dec. 31, 1948	$1,569.44
Total	$32,596.31
Total as of Dec. 31, 1947	$31,280.37
Total as of Dec. 31, 1948	32,596.31
	$1,315.94

Note: This apparently anomalous situation to wit: An increase of $1,315.94 in total amount of invested funds, despite a heavy excess of expenditures over receipts during the year results from the "two for one" stock dividend declared during the year by the Washington Sanitary Improvement Co. and may be thus reconciled:

Increase in invested funds as shown in this report	$1,315.94
Excess of expenditures over receipts for 1948	2,774.06
Increase in book value of stock of Wash. San. Imp. Co.	$4,090.00

At the close of business on December 31, 1948, there were 38 members of the Academy who were in arrears, 26 for 1 year, 10 for 2 years, and 2 for 3 years.

Howard S. Rappleye, *Treasurer.*

REPORT OF AUDITING COMMITTEE

The accounts of the Treasurer of the Washington Academy of Sciences for the year 1948 were examined by your auditing committee on January 11, 1949.

The attached copy of the treasurer's report was checked and found to be in complete agreement with the records, and with the cash balance of the Academy at the American Security & Trust Co. The bank deposits were found to check with the record of the receipts from all sources. All disbursements had been authorized and were found to be supported by vouchers and cancelled checks. The securities of the Society were inspected and found to be in agreement with the list given in the report and to have all coupons attached that are not yet due.

Your Auditing Committee highly commends the Treasurer upon the orderly and businesslike manner in which he has maintained the fiscal records of the Academy.

Harold F. Stimson.
W. G. Brombacher.

REPORT OF THE BOARD OF EDITORS

Volume 38 of the Journal, for the year 1948, contained 425 pages, a loss of about 23 pages as compared with the previous year. There were 47 papers in biology, 13 in the physical sciences, and 11 in other subjects of an interesting nature, making 71 in all. The biological sciences accounted for slightly less than half the number of pages, and the physical sciences for slightly more than one fourth. This represents a large increase in the percentage of pages in the physical sciences over 1947, which was to be expected with a chemist as Senior Editor.

A deluge of price increases in all phases of printing resulted in costs running far above those of the previous year. The disbursements for the Journal during 1948 were:

Printing and mailing	$4,950.22
Illustrations	569.87
Reprints	665.07
Office—Editorial Assistant	300.00
Office—Miscellaneous	35.20
Total	$6,520.36
Charge to authors	918.17
Net cost of the Journal to the Academy	$5,602.19

In 1947, the net cost to the Academy was $3,901.35.

Early in the year the George Banta Publishing Co. notified the Senior Editor that they intended to discontinue printing the Journal about September 1. This action threatened to leave us without a printer for a part of the year, but, through the intercession of Mr. Irwin Wensink, Banta was persuaded to finish the year. Considerable difficulty was at first encountered in interesting publishing houses in printing the Journal, but late in the year three printers became quite anxious to obtain the contract because it would most likely provide a steady income over a long period of years, thereby offering security during dull business periods.

The contract was finally given to Waverly Press of Baltimore, partly because their charge for printing the Journal was quite reasonable and to a greater extent because their charge for reprints was considerably below that of any other printer. This is an item that could not be overlooked because inexpensive reprints should be available to authors who so liberally give their time and energy in order that we may have an Academy publication on a high plane. Special thanks are due Mr. Irwin Wensink, Washington representative of the George Banta Publishing Co., for his help in evaluating the bids for printing the Journal and thereby helping the Board of Editors to choose a satisfactory printer.

The Board of Editors acknowledges the cooperation of the Board of Managers and the officers of the Academy during the trying times of the past year. Special thanks are due Mr. Paul H. Oehser, the Editorial Assistant, who so ably handles the technical side of printing the Journal. Without his services the work of the Board of Editors would be exceedingly difficult.

The high cost of printing the Journal has been a cause of considerable worry to us, but we are convinced that the high quality of the papers and of the Journal during 1948 was well worth the price.

James I. Hoffman.
Alan Stone
Frank C. Kracek.

REPORT OF THE CUSTODIAN AND SUBSCRIPTION MANAGER OF PUBLICATIONS

It will be noticed, on comparison with the figures of reserve sets given in the previous Annual Report (for 1947), that though the number of volumes set aside for reserve sets has been changed slightly from that first specified by the Board of Managers in 1939, the total number of current volumes set aside each year is the same—25.

Subscriptions

Nonmember subscriptions in the United States	131
Nonmember subscriptions in foreign countries	72
Total	203

Inventory of Stock as of December 31, 1948

Reserve sets of the Journal

Complete sets, vols. 1–38	5 sets
Volumes 11–38	6 sets
" 16–38	9 sets
" 21–38	5 sets
Total reserve sets more or less complete	25 sets

Back numbers of the Journal

Numbers in complete sets (5)	3,195
Numbers held in reserve for complete sets	7,783
Numbers available for sale separately	17,495
Total back numbers on hand	28,473

Proceedings

Complete sets, volumes 1–13 (1899–1911)	49 sets

(The copies of the separate articles in the Proceedings have not been counted.)

Sales and Expenditures

During the year no complete sets of the Journal were sold, but 195 separate numbers were sold to various individuals and organizations in this country, Hawaii, Canada, Colombia, Venezuela, Great Britain, Denmark, Sweden, France, Hungary, New Zealand, and China. One complete set of the Proceedings was sold, as were five individual papers from the Proceedings.

427 odd numbers from volumes 1–22 of the Journal were purchased from a second-hand bookdealer for $20. This not only gave us copies of many scarce issues of the early volumes, but enabled us to make up another complete set of the Journal, increasing the number of these sets from four to five. Members of the Academy have continued to generously donate unneeded copies to this office. We are still very desirous of obtaining copies of numbers of the earlier volumes.

Income from Sales

Miscellaneous numbers	$176.90

Expenditures

Purchase of 427 numbers (vols. 1–22)		$21.85*
Postage and office expenses		
Stationary	18.91	
Postage	5.92	
Clerical assistance	5.00	
		29.83
Project for increasing subscription list		
100 postcards	1.00	
100 large envelopes	2.15	
100 3-cent stamps	3.00	
100 extra copies of April 1948 issue	6.66	
100 copies of 1947 index	13.50	
100 copies of circular letter. .		
Printing 100 self-addressed postcards	4.50	
		30.81
Total expenditures		$60.64
Budget allowance		50.00
Deficiency		10.64

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*Deductible from special fund earmarked for purchase of volumes and numbers necessary to complete sets. The present balance in this fund is $89.65.

Campaign for Increasing Subscription List

Early in 1948 the Executive Committee of the Academy asked the Custodian and Subscription Manager of Publications to undertake to increase the number of subscribers to the JOURNAL, and outlined certain proposals for carrying on this campaign. For various reasons this project was not started until late in the year. At that time 100 circular letters were mailed to 100 carefully selected libraries who were not subscribers but who it was felt might be interested in the Journal. A sample number of the JOURNAL was enclosed as well as a copy of the 1947 index, and a self-addressed postcard. To date 4 replies have been received. One represents a new subscription, and two cases are being pursued further, and may result in subscriptions. It is expected that further cards will be returned, and it is hoped that a substantial addition may be made to our list of nonmember subscribers.

Storage of Stock

With the cancellation of the long-standing contract with the George Banta Publishing Co. the question of storing the stock now held in Menasha, Wis., must be considered. An examination of the room in the Smithsonian Institution in which part of the stock is now housed, through the generous cooperation of the officers of that institution, shows, I believe, that with some rearrangement most, if not all, of the material now at Menasha can be stored here. The Academy has been offered further space to house the copies of the Academy's first monograph, by HERBERT FRIEDMANN.

HARALD A. REHDER, *Custodian*
and Subscription Manager of Publications.

REPORT OF THE COMMITTEE OF TELLERS

A total of 293 envelopes were delivered to the Secretary. The count of valid ballots showed the following officers were elected:

President—FRANK H. H. ROBERTS, Jr.
President-Elect—FRANCIS B. SILSBEE
Secretary—FRANK M. SETZLER
Treasurer—HOWARD S. RAPPLEYE
Board of Managers, to January 1952—WILLIAM F. FOSHAG, C. LEWIS GAZIN

JOHN W. MCBURNEY, *Chairman.*
ROGER G. BATES
WILLIAM A. WILDHACK.

REPORT OF THE SPECIAL COMMITTEE ON AN INDEX FOR THE JOURNAL

The need of an adequate index to the nearly 40 volumes of the JOURNAL of the Washington Academy of Sciences has been a matter of growing concern to the Board of Editors and the despair of reference librarians. In fact, the first recommendation of a Committee on the JOURNAL, which reported at the January meeting of the Board of Managers, states: "That an index of the Journal be prepared and published for the first 40 volumes and for each succeeding 10 volumes" (vol. **38:** 79). This matter again came up before the Board of Managers on March 15, when the Editor recommended that the project be prosecuted by the Committee on Monographs, and the President was then authorized to appoint a committee to consider the index and to make recommendations (p. 189).

The Committee was already at work when it received its mandate late in March. It consisted of the Editor and two past editors, two members whose profession is editing, and, by invitation, Mrs. Mabel H. Doyle, chief indexer of the Department of Agriculture. We were to investigate how such an index should be prepared, who should do it, and make some suggestions on means of doing it. After due consideration of what is ideal and what the Academy might afford, the Committee made these findings: (1) that the index be a combined author-subject index; a complete analytical index was abandoned as too expensive; (2) that the work be done by a professional indexer to be found by the Committee; (3) that $1,500 as a minimum ought to be set aside for the preparation of copy, and estimates were secured of printing; (4) that the probable sale is limited to libraries, since members of the Academy will expect to receive copies; and (5) it seemed likely that a subvention might be required and successfully solicited to publish it. Such was the report made to the Board of Managers in May.

The matter having been referred to the Executive Committee, the latter body, meeting May 26, voted to recommend to the Board that it authorize, for the necessary expenses of preparing the manuscript, including the materials, a sum not to exceed $2,000, commencing in 1949 (p. 282). The Board gave its sanction June 7.

This success was quite unexpected, but over the summer the Committee regained its initiative.

After conferring with the Treasurer to ascertain that the funds would be available come January 1, 1949, the chairman convened the group again on October 5 to set the project in motion. Again we met in the office of Dr. Merrill, Department of Agriculture, and once more we had the advice of Mrs. Doyle through whom we secured the interest of Miss Mary A. Bradley. Having enlisted the cooperation of the person who was our first choice to do the work, our troubles were over. It was agreed that one member, Mr. Oehser, would prepare a set of directions for the indexing, and that he would also act as liaison for the Academy and the Committee on matters of policy. The chairman would draw up a contract. A list of subject matter specialists would be furnished. Miss Bradley would index one volume, and then in consultation with the Chairman and Mr. Oehser, would submit an estimate for the entire job.

Having duly reported these transactions to the Board of Managers, the Chairman was authorized to proceed on the basis outlined and to negotiate a contract. In a letter from Miss Bradley to the Chairman, dated November 1, 1948, was received an estimate of $1,500 for preparing and editing a cumulative author-title index to volumes 1 through 40 of the Journal. This estimate was understood to include the preparation and editing of the index in card form, marking the cards for the printer, reading the galley and page proof, and settling problems as they arise until the index is printed, keeping in close touch with the Committee during the work. With the authorization of the Board of Managers, this estimate was accepted November 18; and it was stated as understood that a list of specifications, to be drawn up by Miss Bradley and Mr. Oehser, should be considered as part of the agreement. Accordingly, a contract was prepared in consultation and signed January 5, 1949 by Miss Bradley and the Chairman for the Committee.

One item in the specifications requires comment. Since the certainty of printing the index awaits the further pleasure of the Board of Managers and printing may rest on the possibility of securing a subvention from an outside source, Miss Bradley is held to seeing the proof through the printer only if the Academy forwards the printing within 18 months from the time the index is completed. This is a reasonable request, in the estimation of the Committee. The Index will make an appropriate addition to the Monographs series and might be published with funds appropriated to that purpose.

In addition to the preceding negotiations, which constituted the main work of the Committee, it is a pleasure to report, in conclusion, that work on the index is progressing; one volume is in the hands of the Committee at this time.

JAMES I. HOFFMAN
M. C. MERRILL
PAUL H. OEHSER
H. A. REHDER
WM. N. FENTON, *Chairman.*
Submitted by C. LEWIS GAZIN, *Secretary.*

427TH MEETING OF BOARD OF MANAGERS

The 427th meeting of the Board of Managers, held in the Cosmos Club on April 18, 1949, was called to order at 8:00 P.M., by the President, F. H. H. ROBERTS, Jr. Present were: F. B. SILSBEE, H. S. RAPPLEYE, N. R. SMITH, F. G. BRICKWEDDE, W. W. DIEHL, F. M. DEFANDORF, C. L. GAZIN, F. E. JOHNSTON, J. W. ALDRICH, F. D. ROSSINI, F. A. WEISS, W. A. DAYTON, MARGARET PITTMAN, and F. M. SETZLER.

The President indicated an excellent response to the 364th meeting of the Academy, which was held jointly with the Biological and Entomological Societies of Washington on April 15, 1949, at which Dr. Karl von Frisch, of the University of Graz, Austria, gave an illustrated address on *The language of bees.* Approximately 500 people attended the lecture in the auditorium of the U. S. National Museum.

The President read a memorandum from the Chairman of the Policy and Planning Committee in response to a letter from the American Documentation Institute. The Chairman of the Committee recommended that the Academy should not undertake any additional financial commitments at the present time. The Board approved the recommendation of the Committee.

The President also reported the Academy's activities with regard to the Science Fair, in which 605 high-school students presented exhibits of their work and from whom 48 winners were selected. Twenty out of the 48 winners have been selected by the Franklin Institute to bring their exhibits to Philadelphia on April 23, 1949, as guests of the Institute.

Eleven persons nominated for resident membership and one for nonresident membership at the 426th meeting of the Board of Managers were elected.

Henry W. Bearce and William F. Allen, having retired from the gainful practice of their professions were transferred to the retired list of membership, effective December 31, 1948.

The Secretary reported the deaths of the following members: Carl F. A. Christensen, Universititets Botaniske Museum, Copenhagen, Denmark, on November 24, 1942 (honorary member; elected January 15, 1923); Samuel F. Hildebrand, Fish and Wildlife Service, on March 16, 1949 (elected December 1, 1939); George B. Richardson, U. S. Geological Survey, on March 18, 1949 (elected May 14, 1928; on retired list 1943); William B. Bell, retired, formerly Fish and Wildlife Service, on March 30, 1949 (elected June 3, 1932); Joseph A. Cushman, Cushman Laboratory for Foraminiferal Research, Sharon, Mass., on April 16, 1948 (elected March 25, 1918).

The Treasurer indicated that the statement covering the cost of publication of the first monograph, *The parasitic cuckoos of Africa*, had been received and paid.

The meeting was adjourned at 8:45 P.M.

F. M. Setzler, *Secretary.*

Obituaries

Ernest Clayton Andrews, for 25 years an honorary member of the Washington Academy of Science, died on July 1, 1948. Born at Balmain, an inner suburb of Sydney, New South Wales, on October 18, 1870, of English parents, Andrews received his early education at a local denominational school conducted by the Wesleyan Church where his father, John Andrews, was the sole teacher. His home and school life was conditioned in an atmosphere of strict religious observance with a profound Puritanical strain which discouraged study of the arts and sciences and enjoined attention upon practical matters. Nevertheless the boy, by surreptitious and devious means, became an omnivorous reader of the classics and acquired a deep love for literature and poetic expression. He obtained a scholarship to the Teachers' Training College and entered that institution in January 1891, matriculated in March the same year, enrolled at Sydney University, and graduated bachelor of arts in 1894, specializing in mathematics and geology. While on the teaching staff of the Bathurst Public School he explored the countryside, and arising from his observations came his first paper on geology, presented at the meeting of the Australasian Association for the Advancement of Science held in Sydney in January 1898.

Andrews was nominated in 1898 to undertake the collection of coral reef material in Fiji. He obtained leave of absence from the education department and spent six months in Fiji and Tonga, an experience which he described as "invigorating and helpful." His report on the Fiji trip with a preface by Prof. T. W. Edgeworth David was published in the Bulletin of the Museum of Comparative Zoology, Harvard.

Having obtained permission to attend university courses in geology and chemistry, Andrews was successful in a competitive examination for the position of geologist in the Geological Survey of New South Wales. He was appointed on July 1, 1899, and remained in the Survey until his retirement on December 4, 1931, attaining the top rank of government geologist in January 1920.

In his official post he acquired an unrivaled knowledge of the geology of the State of New South Wales. His investigations were concerned essentially with the economic aspect of the science as applied to problems affecting the major mining fields. Among his many reports published by the Department of Mines the most noteworthy contribution was his epic memoir on Broken Hill issued in 1922, which covered the results of five years of field study and enunciated the basic structural and genetic features of the famous ore bodies so clearly and soundly that his interpretation is acknowledged to have stood the test of subsequent developments and to have been confirmed in principle by a wealth of more detailed surveys since made. He may rightly be regarded as the pioneer Australian geologist in the field of structural economic geology as applied to the study of ore bodies.

His official duties did not deter him from making valuable contributions in other branches of science, especially in physiography, in which he was inspired by the work of W. M. Davis. Notwithstanding adverse criticism he persevered in his originality and contributed many important papers on this subject, of which particular mention may be made of two, viz., *Corrasion by gravity streams* and *The geographical unity of eastern Australia in Tertiary and post-Tertiary times*. He also wrote a number of papers on a variety of structural problems and became particularly interested in such broad concepts as the origin of mountains, stabilization of the continents, and the structural unity of eastern Australia. He was prompted to prepare a manuscript entitled *The plan of the earth*, which he forwarded to the Geological Society of American in 1944 for consideration.

Examinations of the Great Barrier Reef and of coral reefs in New Caledonia and the New Hebrides, as well as his presidential address to the Royal Society of New South Wales in 1922 entitled *Origin of coral reefs in Pleistocene and Recent time*, were evidence of his sustained interest in the subject engendered by his original experiences in Fiji and Tonga.

In 1908 he visited the Sierra Nevada of California and was enabled to continue the studies in ice action which he had begun in New Zealand. During this visit he made the first ascent of Mount Darwin.

Brilliant though he was as a geologist, Andrews won equal renown as a botanist. He became especially interested in the Myrtaceae and Leguminosae, contributing papers on the origin and distribution of both groups as well as a notable paper on the geological history of the Australian flowering plants. In many instances he made practical use of his knowledge of the habitats of the native flora in mapping the boundaries of rock types in heavily timbered country.

In recognition of his scientific attainments many honors were bestowed upon him, notably the David Syme Prize and Medal from the University of Melbourne (1915), the Clarke Memorial Medal from the Royal Society of New South Wales (1928), the Lyell Medal from the Geological Society of London (1931), and the Mueller Memorial Medal from the Australian and New Zealand Association for the Advancement of Science (1946). In addition, he was invited to deliver the Silliman Lectures at Yale (1927) and the Clarke Memorial Lecture for the Royal Society of New South Wales (1942). He was elected an honorary member of the Washington Academy of Sciences on January 15, 1923.

Activities designed toward the advancement of science in Australia and the Pacific received his whole-hearted support, as is evidenced by his membership of the following bodies: Royal Society of New South Wales (president 1921); Linnean Society of New South Wales (president 1937); Australasian Association for the Advancement of Science (president 1930); Australian National Research Council; Australasian Institute of Mining and Metallurgy (president 1929). He was a delegate to the Second Empire Mining Congress, Canada, 1927, and attended the Pan Pacific Science Congresses held in Honolulu, Australia, Japan, Java, Canada, and United States, the three last-mentioned as leader of the Australian delegation.

In 1909 he married Florence May Byron, who died in 1923. In 1929 he married Mabel Agnes Smith, daughter of John H. Smith, First Unitarian Minister, Sydney.

He had an intense love of music and in later years devoted his attention to the philosophical and spiritual side of life, publishing two small books giving his views—*The increasing purpose* (1939) and *The eternal goodness* (1948).

Andrews not only enjoyed a very high reputation as a scientist but was held in the highest esteem by his colleagues and friends for his kindly nature, his unfailing courtesy, and his willingness at all times to advise and assist all who sought his wise counsel.

WILLIAM HARVEY EMMONS was born at Mexico, Mo., on February 1, 1876, and died at his home in Minneapolis on the evening of November 5, 1948, where he was still pushing forward his current research.

In 1897 when young Bill Emmons was through with his football days at Central College in his native State of Missouri, he plunged into graduate work in geology at the University of Chicago with the warmhearted zest and enthusiasm that always remained perhaps his most characteristic trait. His thesis area lay in the rugged mountains of southern Montana, and here he found the mental challenge and physical adventure that to him made geology the most fascinating pursuit in the world. Recalling this first field work in the thin air of the high mountains he said, "That's wonderful country! You sit down on a mountain and feel like an angel!—until you get up." It was inevitable that as soon as he got his Ph.D. degree in 1904, he would join the U. S. Geological Survey to study the geologic hinterlands of the United States. His innate friendliness and genuinely democratic fondness for people, together with a keen mind and unbounded energy, made his work in the rough, tough mining camps a long series of happy, satisfying adventures.

Whether rushing into camp for a hurried shower before spending half the night with a local singing club, or miles away in the desert excitedly tracing a fault till darkness interfered, the husky young cub seemed to squeeze the joy of living out of every moment of each long day. His coworkers respectfully nicknamed him Bill "Horse" Emmons and—affectionately—"Wild Bill."

In 1907 he began to devote part of his time to lecturing at the University of Chicago, and in 1909 accepted a position as associate professor of petrology and economic geology. In 1910 he married Miss Virginia Cloyd.

At the University of Minnesota, where he was called to head the department of geology in 1911, he soon surrounded himself with a brilliant and harmonious group of teachers, destined to become internationally known for the excellence of both their teaching and research. He was a scholastic lodestone himself, and students at all levels of training flocked to his classes.

Dr. Emmons's great talent for teaching lay in his ever-broadening background of field experience, his amazingly detailed knowledge of the literature, an easy extemporaneous delivery, and, above all, in the contagion of his absorbed enthusiasm for his subject. One of his undergraduates once remarked, "He is the only professor I know who can climb on a desk to point out a place on the map, forget to get down for the rest of the hour, and not have the class think it funny."

Teaching took only a part of his long work day, however; there always seemed to be plenty of time for writing, research, consulting work, and for talking to students and visitors. Although he often worked 18 hours day after day when delving into some new and fascinating bit of research, and at such times might pass his closest friends without recognizing them, such intense preoccupation was only intermittent; between times he made the most of his social contacts, and whether playing with his children, Betty and Bill, or indulging in a bridge game at the Faculty Club his ringing laugh and humorous anecdotes enthralled his companions.

He took a boyish pleasure in earning the substantial fees that accompanied commercial work; but the problems, the travel to far places, were the primary attractions in this new theater of operations. The stock market crash of 1929–30 wiped out a large part of his investments, leaving him frankly bewildered but only momentarily downcast; his ebullient spirit and saving sense of humor carried him blithely through what others would have called disaster. After all, his satisfactions were in the production of such valuables at *The enrichment of ore deposits*, *Principals of economic geology*, *The geology of petroleum*, *Primary downward changes in ore deposits*, and *Gold deposits of the world.*

After a severe and protracted case of pneumonia when about 64, Dr. Emmons began to find his strenuous program of classwork and research much restricted by the need for rest. Retiring from "active work" in 1944 at the age of 68, he was nevertheless busily engaged in preparing a companion volume to *Gold deposits of the world* when he died. His genius for kindling others with the fire of enthusiasm was perhaps his greatest gift; and the contributions of literally hundreds of able geologists all over the world carry on the work, inspired by one of the great teachers of modern geology.

T. S. Lovering.

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VOL. 39 JULY 15, 1949 No. 7

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

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This Journal, the official organ of the Washington Academy of Sciences, publishes: (1) Short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The Journal is issued monthly, on the fifteenth of each month. Volumes correspond to calendar years.

Manuscripts may be sent to any member of the Board of Editors. It is urgently requested that contributors consult the latest numbers of the Journal and conform their manuscripts to the usage found there as regards arrangement of title, subheads, synonymies, footnotes, tables, bibliography, legends for illustrations, and other matter. Manuscripts should be typewritten, double-spaced, on good paper. Footnotes should be numbered serially in pencil and submitted on a separate sheet. The editors do not assume responsibility for the ideas expressed by the author, nor can they undertake to correct other than obvious minor errors.

Illustrations in excess of the equivalent (in cost) of one full-page halftone are to be paid for by the author.

Proof.—In order to facilitate prompt publication one proof will generally be sent to authors in or near Washington. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Unusual cost of foreign, mathematical, and tabular material, as well as alterations made in the proof by the author, may be charged to the author.

Author's Reprints.—Reprints will be furnished in accordance with the following schedule of prices (approximate):

Copies	4 pp.	8 pp.	12 pp.	16 pp.	20 pp.	Covers
100	$2.48	$4.96	$ 7.44	$ 9.92	$12.40	$2.09
150	3.72	7.44	11.16	14.88	18.60	3.14
200	4.96	9.92	14.88	19.84	24.80	4.18
300	7.44	14.88	22.32	29.76	37.20	6.27
400	9.92	19.84	29.76	39.68	49.60	8.36

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ETHNOLOGY.—*The case of Daniel P.: An example of Seneca healing.*[1]

GEORGE S. SNYDERMAN, University of Pennsylvania. (Communicated by W N. FENTON.)

It is unfortunate that despite the vast amount of published ethnological material on the American Indians the student interested in primitive medicine finds many gaps in the data which prevent him from drawing complete and satisfactory conclusions. There is a primary need for a description and analysis of medical practices for each individual tribe; there is an extensive need for actual case studies before the primary need may be satisfied. It is true that an anecdote may prove little or nothing. The one recorded in this paper, however, well illustrates how the Seneca individual doctors went about their business of curing. We have chosen to use "individual doctor" rather than "lay healer" at Dr. A. I. Hallowell's suggestion, since the latter term connotes an individual with little or no training—a person with amateur status. My informants stated that the female doctors mentioned herein had served long periods of "apprenticeships" in order to learn the secrets of their profession. They were considered fully qualified to heal by other members of the tribe. This was as official as a certificate from a State Board of Examiners.

The incident under discussion, which we chose to call the Case of Daniel P., was recently related to us by a Seneca informant.[2] To the best of our knowledge it is the first published material to include a step-by-step description of one type of healing by individual doctors together with some of the underlying philosophy that these people hold toward the patient and the treatment.

The reader will note that two factors are closely intermingled in Seneca healing[3]—specific practices prescribed for a pathological condition and socially accepted attitudes and beliefs attendant with these practices. We do not feel that the practices can be discussed realistically without considering the attitudes and beliefs of the people, for Seneca medicine depends not only on the use of purely medicinal treatments (as we know them), but also upon the use of magico-religious procedures.

Seneca healing takes several forms. A patient may be treated either by individual healers or by a medicine society. The case under discussion is an analysis of the attitudes and beliefs found to surround the treatment of an individual who was doctored by individual physicians. In this treatment

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[1] Received March 31, 1949. Funds for field work for this study were made available by the Anthropology Department of the University of Pennsylvania. Thanks are due to Profs. F. G. Speck and A. I. Hallowell, of the University of Pennsylvania; Dr. W. N. Fenton, of the Smithsonian Institution; and M. H. Deardorff, of Warren, Pa., for many helpful suggestions. The correct name of the patient is withheld.

[2] This group of Seneca live near Quaker Bridge, N. Y.

[3] No attention is given herein to the medicine societies that exist among the Seneca. The reader is referred to Fenton (1941b) for information on this subject; the subject of Seneca herbalism is also neglected in this article. Those interested in this subject may refer to Fenton (1942). Parker (1912) describes witch doctors as "witches who are willing to pit their power against other witches, and medicine men who have made a special study of charms that will offset witch spells" (footnote pp. 27–29). The reader will note that the type of healing herein described has both strong elements of witchcraft, and also elements of medicinal healing.

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strong religious principles and practices may be noted. In addition to the faith in the healing properties of the medicine, there is also a reverential feeling toward the medicine itself. This is exemplified in the practice of burying any medicine remaining after the treatment so that it "will not be walked on or otherwise desecrated by man or beast." It is axiomatic that medicine is never thrown away!

Lena Snow, the senior matron of the Turtle Clan, narrated the case, which she witnessed as a little girl. She estimated that Daniel "must have been doctored over 60 years ago," during times when her people "had more faith" in their own medicines and did not resort "to white man's medicines" for every ill that befell them. She attributed the present-day ineffectiveness of Indian medicine to the "lack of faith in their power" (Snyderman, 1948).

MRS. SNOW'S STORY

Daniel P., a Tuscarora who had accepted the Christian faith, became crazy. He kept complaining about the whites. Even though he was bedridden, he wanted to get up and run away into the woods. After a while he became so violent that he had to be held down. Once he ran away into the woods and tried to kill himself with a sword.[4] The Christian doctors tried everything but could not help him. He kept getting worse.

After awhile, his son brought him to an Indian medicine woman, Sarah Dockstetter, who lived near Red House, N. Y. Mrs. Dockstetter prepared medicine which she had successfully used in these kinds of illnesses, but Daniel fought against taking the medicine. If he was forced to take it, he would spit it out. So finally his son took him home to Tuscarora.

Daniel continued to get sicker, so his son brought him back to Cold Spring. This was about two or three weeks later. He took him to see Mrs. Yellow Blanket, a famous herb doctor. Mrs. Yellow Blanket agreed to take the case and got Hiram Watt's mother to help her.[5]

The two doctors prepared about a quart of medicine which Daniel willingly drank shortly before sunrise—about 4 A.M. The medicine made him puke into a pan which I held for him. At sunrise I was ordered to search the pan. I found pieces of gold and silver beads, and I put these into a bottle of medicine which the doctors prepared for this purpose.

Daniel was given a cup of medicine every day for the succeeding seven days and Lena continued to examine the vomit for foreign objects.

The second day I picked out two little black sticks about a quarter of an inch long with fine hair wound around it. The third day I found a small stick with no hair around it. The fourth day I took out a pyramid-shaped black thing. During the following three or four days I found nothing, so the "puking medicine" was discontinued and Daniel was given a strong physic to clean him out.

During the entire cure, Hiram Watt's mother, who acted as Mrs. Yellow Blanket's assistant, soaked Daniel's feet in a special medicine every time he got through puking.

Soon[6] Daniel began to talk sense and look around. He stopped saying "Let's get out—the whites are here and will kill me." He said he could not take Mrs. Dockstetter's medicine because it tasted like chicken dirt, whereas Mrs. Yellow Blanket's medicine not only tasted good but was so strong that it forced him to take hold of the cup and drink it right down without fighting.

According to Mrs. Snow, Daniel P. never manifested the same symptoms again. However, he "felt weak" on one occasion and "went to see a white doctor who ordered him to take a tablespoon of whiskey as a tonic." As a result of this Daniel began to drink steadily. He eventually died a confirmed drunkard. Lena emphasized that "if he had returned to Allegany, he could have been cured because witches caused the whiskey to be bad medicine, and only the Indian doctors could cure anyone who was witched." An essential belief expressed herein is that Daniel's drunkenness is the end result of witchcraft and that the whiskey which was prescribed as a medicine acted as the vehicle for it.

Another consideration is pertinent: The unconscious resentment toward the whites that is found in Mrs. Snow's statement is commonplace in Allegany even among the Seneca who do not follow the "old way." Resentment toward the whites may be noted also in the case itself. This is seen in the overt fear of further white encroachments which was manifested by Daniel P.'s desire to escape into the woods. To him hiding in the woods may have symbolized the comparative safety from attack that existed prior to the white man. One can collect literally hundreds of statements regarding the significance of the forests to the Seneca people—trees and forests play an important role in Seneca religion and folklore. The fact that white man was primarily responsible for the extensive clearing of the virgin Appalachian forests may have some deep-rooted psychological implications that motivate present-day Seneca attitudes and behavior.

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[4] Fenton, 1941a, has discussed Iroquois suicides.

[5] The treatment was administered in the home of Mrs. Snow.

[6] Apparently after 10 days' treatment.

The substitution of the white man's medicine and the concomitant rejection of the Indian medicine merit further comment.[7] Mrs. Snow indicated that it was a "shame that the Indians no longer utilized their own medicine." She stated that because of the efforts of the whites, they had discarded tested cures for hit-or-miss methods. It would be easy to dismiss this as a nostalgic longing of an elderly person if it were an isolated attitude; but we found this philosophy to be held in common by many of the older "Long House People."[8]

However, despite the gradual return of many of the younger people to the Long House, which has resulted in a renaissance of the "old religion," there does not seem to be a similar acceptance of the old faith in healing by individual Indian doctors. And since the medical care to which the younger element avails itself is virtually a white monopoly, the resentment of the individuals believing in lay healing is further aggravated.

Among the Seneca, the belief in the power of the medicine to heal was and still is positively correlated with the actual cure.[9] Thus, Ed. Curry, the present keeper of the "Little Water Medicine," told me of a man who had been given their medicine but who would probably not get well because he had first tried all of white man's medicine and called for the "real medicine" only as a last resort. He decried the fact that many Indians "did not have faith" in their own medicines and used them only when it was too late. "People," he said, "had faith in the medicines, so the medicines worked."[10] To the Seneca believer this is no mere rationalization for the failure of Indian medicine, but prima-facie evidence for the need of a complete return to the ways of the "old people."

Obviously underlying Daniel's treatment is the subject of witchcraft. This phenomenon was so much a part of Seneca thinking that Handsome Lake, the great prophet, defined witches as "people without their right minds" who "make disease and spread sickness to make the living die." Handsome Lake attacked the problem by providing for a method of curing witches rather than curing persons afflicted as a result of witchcraft. His message is still recited at religious functions in the Long House.[11]

Lena Snow indicated that Daniel had been "witched" and that the person "witching him had used his power to make him sick."[12] The good medicine when administered was sufficiently potent to overcome the evil medicine of the witch. The power of Mrs. Yellow Blanket and her assistant was unquestionably stronger than the power of the witch. In fact, it was strong enough to force the patient to take it in large enough doses to ensure a cure.[13] And what is more, it succeeded where Mrs. Dockstetter's medicine failed simply because Mrs. Dockstetter's did not have sufficient power. These were incontrovertible facts.

In conclusion, it may be seen that the Seneca regarded certain types of illness as due to the failure of the individual's personal power to protect him from witches who place material objects in his body. Accordingly, the witches destroyed his physical and mental health. The treatment accorded was therefore geared to remove these foreign objects and to act as a positive path for physical and mental health. It was literally a contest between the forces of good and evil. Ackerknecht's statement that primitive peoples do not recognize a dichotomy between physical and mental disease[14] seems to apply generally to the Seneca and specifically to the treatment prescribed for Daniel P. A study of this case also revealed basic fears and anxieties that accompanied white intrusion. These psychological phenomena remain despite Seneca return to some of their old social and religious beliefs and may well be explored by students interested in this problem.

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[7] The feelings of anxiety that have accompanied acculturation of primitive peoples are discussed by Hallowell (1945) and Fenton (1948).

[8] Virtually the same opinion was expressed by Fannie Stevens, Chauncey Johnny John, Ed. Curry, Charlie Butler, Sherman Redeye, and others.

[9] This would seem to underlie much of our own medicine.

[10] Snyderman, 1948, op. cit.

[11] Parker, *op. cit.* pp. 27–29, for text of Handsome Lake's message.

[12] Fannie Stevens (*ibid.*) stated that "witches could cause people to swallow small skeins of thread, balls of animal hair, needles and beads."

[13] Ackerknecht (1942a, p. 506) calls this "counter magic".

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[14] Ackerknecht, 1945, pp. 33–34.

PALEONTOLOGY.—*A leptictid insectivore from the middle Eocene Bridger formation of Wyoming*.[1] C. Lewis Gazin, U. S. National Museum.

During laboratory preparation at the U. S. National Museum of a large *Palaeosyops robustus* skeleton from the Bridger formation, a small insectivore maxilla was encountered in the adhering matrix. Particular interest is attached to this occurrence in demonstrating for the first time the presence in middle Eocene or Bridgerian time, of a leptictid related to the *Diacodon-Ictops* line, bridging a conspicuous hiatus in the recorded geologic range of this group.

The titanothere which the leptictid maxilla accompanied was found by George B. Pearce of the 1930 Smithsonian Institution expedition. The horizon is determined as D_2, according to the stratigraphic subdivisions set up by Matthew.[2] Its location was approximately 3 miles north of the town of Lone Tree, Wyo., on the north slope of the divide between Sage Creek basin and Henry's Fork, and a little above the "Lone Tree white layer," in SE$\frac{1}{4}$, sec. 18, T. 13 N., R. 113 W.

GEOLOGIC DISTRIBUTION OF LEPTICTIDS

The oldest known probable leptictid is *Gypsonictops hypoconus*, which Simpson[3] described from the Hell Creek and Lance upper Cretaceous, a form surprisingly similar to the later leptictids, indicating this to be a remarkably conservative group and, so far as known, one of the earliest placentals.

Leptictids are rather well diversified in the Paleocene, if one is to judge by the

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received March 3, 1949.

[2] Mem. Amer. Mus. Nat. Hist. **9**: 295–297. 1909.

[3] Amer. Mus. Nov. **267**: 6–7, fig. 6. 1927. Also, Mem. Peabody Mus. Yale Univ. **3**(1): 137–138, fig. 53, pl. 32, figs. 3–7. 1929.

number of forms which have been named, but in all, conservative in development, so far as dentitions are concerned. Among the Paleocene forms have been included such genera as *Myrmecoboides*, *Leptacodon*, *Acmeodon*, *Prodiacodon*, and possibly *Xenacodon* in North America alone. The first of these was described by Gidley[4] in 1915, as a marsupial, on the basis of material from the "Gidley Quarry" in the upper Lebo of the Montana Fort Union. Matthew[5] and later Simpson[6] properly referred *Myrmecoboides montanus* to the Leptictidae. *Leptacodon* and *Xenacodon* were named by Matthew and Granger[7] in 1921 for leptictid species from the Tiffany beds, and subsequently species of *Leptacodon* were recognized by Simpson in the Bear Creek fauna[8] (*Leipsanolestes siegfriedti*) and in the upper Lebo[9] of Montana, and by Jepsen[10] in the Silver Coulee horizon of the Polecat Bench series. In 1921 Matthew and Granger[11] also described *Acmeodon secans*, from the Torrejon beds, and more recently *Prodiacodon* was proposed by Matthew[12] for his Torrejon species, *Diacodon* (*Palaeolestes*) *puercensis*,[13] and to replace *Palaeolestes* (preoccupied). *Emperodon*,[14] described first as a Lebo deltatheridiid and then shown[15] to be a synonym of *Gelastops*, appears listed (probably in error) by Simpson[16] in 1945 as a leptictid.

The genus *Diacodon*, based on the species *Diacodon alticuspis*, was first described by Cope[17] in 1875 from the "Wasatch" beds, which Simpson[18] has recently named the San Jose formation, in the San Juan Basin of New Mexico. It is not known whether the type specimen, essentially a lower jaw, was derived from Almagre or the Largo member, but the time difference between these two horizons is probably not so significant as was once thought, and the two are probably not so high in the Wasatchean interval. A second species from these beds, which Cope called *Diacodon celatus*, has since been transferred to the genus *Nyctitherium*, and hence to a different family.

In 1880 Cope[19] described the species *Stypolophus bicuspis*, which he later referred to *Ictops* and to which Matthew[20] in 1899 gave the name *Palaeictops* (not Cope, as Granger[21] in 1910 indicated), but later[22] showed that it properly belongs in the genus *Diacodon*. The *Diacodon bicuspis* type, a remarkably good specimen, including skull and lower jaws, was collected by Wortman from the Wind River beds in 1880. The collection which Wortman made at that time was later interpreted by Granger and by Matthew as coming from the Lost Cabin horizon. A second form from the Lost Cabin beds, *Parictops multicuspis*, was described by Granger[23] in 1910. *P. multicuspis* is known only from a lower jaw which is characterized by larger, more cuspate, and somewhat more shearing premolars. No information is available as to the variability of *Diacodon bicuspis* in this respect, however, in *Ictops* there is a noticeable variation in the extent to which premolar cuspules are developed. Nevertheless, *Parictops* appears from the limited material to be a valid genus.

Certain references to *Diacodon* in Paleocene, as noted above, were later incorporated under *Prodiacodon*. There remains, however, the occurrence of *Diacodon minutus* Jepsen[24] in the Silver Coulee horizon of the Polecat Bench in Wyoming, and of *Diacodon septentrionalis* Russell[25] from the Paskapoo of Alberta. The age of the Wyoming material is not in doubt, but the Alberta occurrences are described in association with materials which do not appear compatible, such as *Chriacus* and *Meniscotherium*.

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[4] Proc. U. S. Nat. Mus. **48**: 395–402, pl. 48, figs. 1–1a. 1915.

[5] Science, n.s., **43**: 109–110. 1916. Also, Trans. Amer. Philos. Soc., n.s., **30**: 215–216. 1937.

[6] U. S. Nat. Mus. Bull. 169: 115–118, figs. 17–18. 1937.

[7] Amer. Mus. Nov. **13**: 2–3. 1921.

[8] Simpson, George G., Amer. Mus. Nov. **297**: 6, figs. 3–3a. 1928.

[9] Simpson, George G., U. S. Nat. Mus. Bull. **169**: 113–115, figs. 15–16. 1937.

[10] Proc. Amer. Philos. Soc. **69**: 510–511, pl. 8, figs. 4–5. 1930.

[11] Amer. Mus. Nov. **13**: 3–4. 1921.

[12] Journ. Mamm. **10**: 171. 1929.

[13] Matthew, William D., Bull. Amer. Mus. Nat. Hist. **38**: 576–579, figs. 6–8. 1918.

[14] Simpson, George G., Proc. U. S. Nat. Mus. **83**: 229. 1935.

[15] Simpson, George G., U. S. Nat. Mus. Bull. **169**: 107–110. 1937.

[16] Bull. Amer. Mus. Nat. Hist. **85**: 48. 1945.

[17] Cope, Edward D., Engineer Dept., U. S. Army, Geogr. Expl. and Surveys West of 100th Meridian, 1st Lt. Geo. M. Wheeler in charge, pp. 11–12. 1875.

[18] Amer. Journ. Sci. **246**: 258. 1948.

[19] Amer. Nat. **14**: 746. 1880.

[20] Bull. Amer. Mus. Nat. Hist. **12**: 35. 1899.

[21] Bull. Amer. Mus. Nat. Hist. **28**: 250. 1910.

[22] Matthew, William D., Bull. Amer. Mus. Nat. Hist. **38**: 574–576, figs. 3–5. 1918.

[23] Bull. Amer. Mus. Nat. Hist. **28**: 250–251, fig. 6. 1910.

Eocene leptictids of later than Bridger time include Peterson's[26] *Protictops* from the Duchesne River beds and possibly *Sespedectes* described by Stock[27] from the uppermost Eocene equivalent of the Sespe in California. The culminating stage in North America is seen in the White River Oligocene forms, *Ictops* and *Leptictis*, the earliest described[28] members of the family. Species of *Ictops* are abundantly represented in the Chadronian and Orellan intervals, but *Leptictis* remains known only from the type specimen of *L. haydeni*. It has been suggested before that this specimen may be an abnormal individual of *Ictops dakotensis*. *Mesodectes* Cope[29] is regarded as a synonym of *Ictops*, and *Metacodon* Clark[30] is described as a survival into Oligocene time of the *Leptacodon* type of dentition. Patterson and McGrew,[31] however, transferred *Metacodon* to the Erinaceidae on evidence furnished by additional materials from the Brulé White River beds.

Hypictops[32], n. gen.

Type.—*Hypictops syntaphus*, n. sp.

Generic characters.—Upper premolars relatively large. Molars broad lingually. M^3 unreduced. Parastyle exceedingly well developed on P^3, but apparently weak on succeeding cheek teeth. Cingula very weak on all teeth and hypoconal crest joining protocone at a decidedly basal level.

Hypictops syntaphus[33], n. sp.

Type.—Right maxilla with P^2 to M^3 and part of P^1; U. S. N. M. no. 13445.

Horizon and locality.—Upper Bridger (D_2), about 3 miles north of Lone Tree, Bridger Basin, Wyo.

Specific characters.—Size near that of *Diacodon bicuspis*. P^4 to M^2 smaller than in *Ictops dakotensis*. Specific characters for the most part not distinguished from those of the genus.

Description.—The teeth (see Fig. 1) in the maxillary portion of *Hypictops syntaphus* are well preserved, but at the same time rather well worn. Only the basal portion of the two rooted P^1 is preserved, and P^2 is not complete anteriorly. The remaining cheek teeth are essentially complete, except for slight damage labially to the adjacent root portions of M^1 and M^2.

The premolars of this form are of relatively large size in comparison with other leptictids, with the primary cusp in P^2 and P^3 transversely broad and robust. The tritocone or metacone on both is high and well defined, more noteworthy for this in P^2. The presence or absence of a parastylid on P^2 cannot be determined, but on P^3 this cusp is high and prominent. It is but slightly developed and very basal in position in P^3 of *Diacodon bicuspis*, and weak or vestigial in *Ictops*. *Diacodon tauri-cinerei*[34] exhibits a moderately strong, but decidedly lower, cusp in this position. The deuterocone portion of P^3 shows strong wear but is prominent and anteroposteriorly broad. A slight cingulum is present only along the posterior margin of the tooth and posteroexternal to the tritocone.

The succeeding molariform teeth have exceedingly weak external cingula, not at all like lower Eocene *Diacodon*, or the Paleocene forms which in turn exhibit an even more noticeable development of this character. The reduction of the external cingulum, though greater, is more nearly comparable to that in *Ictops*. The para- and metastyles, nearly obliterated by wear, were, apparently, not particularly well developed, at least not in the true molars. There is some evidence through tooth spacing and root placement that P^4 may have had a moderately developed parastyle and metastyle, though scarcely as much as in *Diacodon bicuspis* or *Diacodon tauri-cinerei*. The lingual portions of the molariform teeth are broad and elongate, not so acute lingually as in *Diacodon* and earlier forms in general, or so arcuate as in *D. tauri-cineri*. The lingual portions of these teeth resemble more nearly those in *Ictops*, but with the hypocone not so highly placed on the posterior wall of the protocone. The hypoconal crest is separate from the protocone to a more basal position. A very slightly developed anterior cingulum is present on the forward wall of the protocone of each of these teeth. Lastly, the third molar is well developed, resembles that in *Ictops*, but is less reduced in size and without the cingulum around the lingual margin of the tooth.

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[24] Proc. Amer. Philos. Soc. **69**: 511–513, pl. 9. figs. 7–9. 1930.

[25] Amer. Journ. Sci. **17**: 166–168, 173–175, fig. 2 1929.

[26] Ann. Carnegie Mus. **23**: 374–375, fig. 1. 1934.

[27] Proc. Nat. Acad. Sci. **21**: 218–219, pl. 1. figs. 6–6a. 1935.

[28] LEIDY, JOSEPH. Proc. Acad. Nat. Sci. Philadelphia **20**: 315–316. 1868.

[29] Engineer Dept., U. S. Army, Geogr. Expl. and Surveys West of 100th Meridian, 1st Lt. Geo. M. Wheeler in charge, p. 30. 1875.

[30] Ann. Carnegie Mus. **25**: 310, pl. 26, figs. 1–2. 1937.

[31] Publ. Field Mus. Nat. Hist., Geol. ser. **6**: 257–269, figs. 66–72. 1937.

[32] ‘*υπό*, under; plus *Ictops*: in allusion to its stratigraphic relationship.

[33] *σύνταφος*, buried with: in allusion to its burial with *Palaesyops robustus*.

[34] JEPSEN, GLENN L., Proc. Amer. Philos. Soc. **69**: 124–126, pl. 3. 1930.

Discussion.—It seems possible, from the limited information available, that *Hypictops syntaphus* is closely related to *Parictops multicuspis* Granger from the Lost Cabin horizon. The latter was described from a lower jaw, but the relatively large size of the lower premolars and the development of highly placed cusps on the anterior and posterior margins of the protoconids of these teeth is suggestive. A Princeton specimen (no. 13419) from Cottonwood Creek in the Wind River Basin, hence probably Lysite in age, resembles *Parictops multicuspis* and has certain upper teeth exposed, including the second, third, and part of the fourth premolars, as well as a third molar. The crowns of P^2 and P^3 are partly broken down, but P^2 exhibits anteriorly a very small, basal parastyle, a medianly elevated tritocone, and a small posterior cingular cusp. P^3 exhibits a parastyle as in *Hypictops syntaphus*, but there is evidence of a posterior cingular cusp as in P^2, not present in these teeth of the Bridger form. The premolars are little more than half the size of those in *H. syntaphus*. P^4 is too incomplete for comparison, but M^3 is relatively much narrower transversely and has a far better developed hypocone than in *H. syntaphus*.

Little can be said at this time, without a more comprehensive review of all the leptictid material, as to the phylectic lines within the family, or as to whether more than one line can be certainly defined. In any case, it appears that *Hypictops syntaphus* differs from both *Diacodon* and *Ictops*, but can not be regarded as intermediate in all respects to these two. *Hypictops* may be derived from *Diacodon*, possibly through *Parictops*, whereas *Ictops* appears more likely to have been derived from *Diacodon* through some other line.

MEASUREMENTS IN MILLIMETERS

Length of dentition P^1 to M^3, incl.	23.0
Length of premolars	14.8
Length of molars	8.3

	P^1	P^2	P^3	P^4	M^1	M^2	M^3
Anteroposterior diameter externally	2.6	[a]3.8	4.3	3.5	[a]2.9	[a]2.9	2.5
Anteroposterior diameter lingually				2.3	2.4	2.3	1.9
Transverse diameter at right angles to tooth row	1.2	1.5	3.1	4.4	4.6	4.8	3.9

[a] approximate.

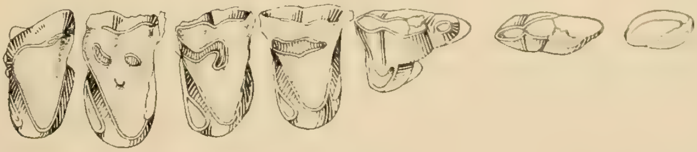

Fig. 1.—*Hypictops syntaphus*, n. gen. and sp.: Occlusal view of right upper dentition, P^1 to M^3, incl. U.S.N.M. no. 13445. ×4. Drawing by William D. Crockett.

PALEOBOTANY.—*Pliocene plants from Cachee Valley, Utah.*[1] ROLAND W. BROWN, U. S. Geological Survey.

The fossil plants described here are the first from the Pliocene of Utah. They were collected by J. Stewart Williams, of the Utah State Agricultural College, Logan, Utah, from eastward-dipping outcrops of grayish white, thin-bedded, tuffaceous marl of the Salt Lake formation, in the left bank of Little Bear River in SE¼, sec. 20, T. 10 N., R. 1 E., between Hyrum and Paradise; and from platy, gray limestone in sec. 13, T. 12 N., R. 2 W., about 10 miles west of Logan, Utah. Besides plants, the strata also contain insect remains, ostracods, fresh-water mollusks, fish bones, and bird feathers.

According to Williams (*7*, pp. 1147, 1160) the Salt Lake formation in the Cache Valley of Utah unconformably overlies Paleozoic rocks and comprises tuffaceous marls, limestones, oolites, sandstones, and conglomerates that crop out in irregular patches in the foothill benches around the margins of the valley. The strata represent sediments deposited in a lake that occupied what is now a graben whose limiting faults coincide roughly with the valley boundaries. The maximum altitude of the outcrops approximates 6,000 feet or more.

Plant material from the Salt Lake formation is relatively scarce, and such as is found is fragmentary, which is evidence of destruction caused probably by attrition in the course of fluvial transportation out of the hills to the basin of deposition. Only the tougher and smaller leaves, some seeds, and broken pieces of stems survived the journey. The most abundant plant is a rootstock that resembles those of horsetails but is probably from a monocotyledon such as a grass or sedge that grew along the lake shore or on the banks of the lower reaches of tributaries to the lake. Some plant species are represented by only one specimen and its counterpart, and, consequently, characterization or identification of these specimens should be considered tentative, pending the accumulation of further material.

SYSTEMATIC DESCRIPTIONS

GYMNOSPERMS

Juniperus sp. Fig. 2

The leaves of this fragmentary twig are scalelike and opposite one another in pairs. Although this twig resembles those of *Chamaecyparis*, *Juniperus*, and *Thuja*, the likelihood is that it came from a juniper like the Utah juniper, *Juniperus utahensis* Lemmon.

CONIFEROUS NEEDLE Fig. 1

This broken needle is conspicuously grooved, suggesting the genus *Abies*, but it may represent a pine. No cone scales or other pertinent remains occur in the collection to aid in its identification.

ANGIOSPERMS

MONOCOTYLEDONS

GRASS Fig. 8

The collection contains numerous fragments similar to that figured. As no sheaths indicating *Equisetum* are present at the nodes, it is likely that these rootstocks represent a grass.

DICOTYLEDONS

SALICACEAE

Salix sp. Fig. 13

This willow leaf with the serrate margin and conspicuous intersecondaries has some resemblance to specimens referred to the fossil *Salix hesperia* (Knowlton) Condit (*3*, p. 316, pl. 53, fig. 1), but I hesitate to make this definite assignment without corroborative material.

Salix paradisensis Brown, n. sp. Fig. 23

Leaf lanceolate, coarsely serrate, with a short, stout petiole. Secondary veins numerous but intersecondaries few. The specimen resembles some of the leaves of *Salix scouleriana* Barratt and of the pussy willow, *S. discolor* Muhlenberg.

Salix williamsi Brown, n. sp. Fig. 24

Leaf oblanceolate, with rounded apex, cuneate base, and entire margin. The secondaries are closely spaced but intersecondaries are scarce. Petiole short. The leaf resembles those of

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[1] Published by permission of the Director, U. S. Geological Survey. Received March 9, 1949.

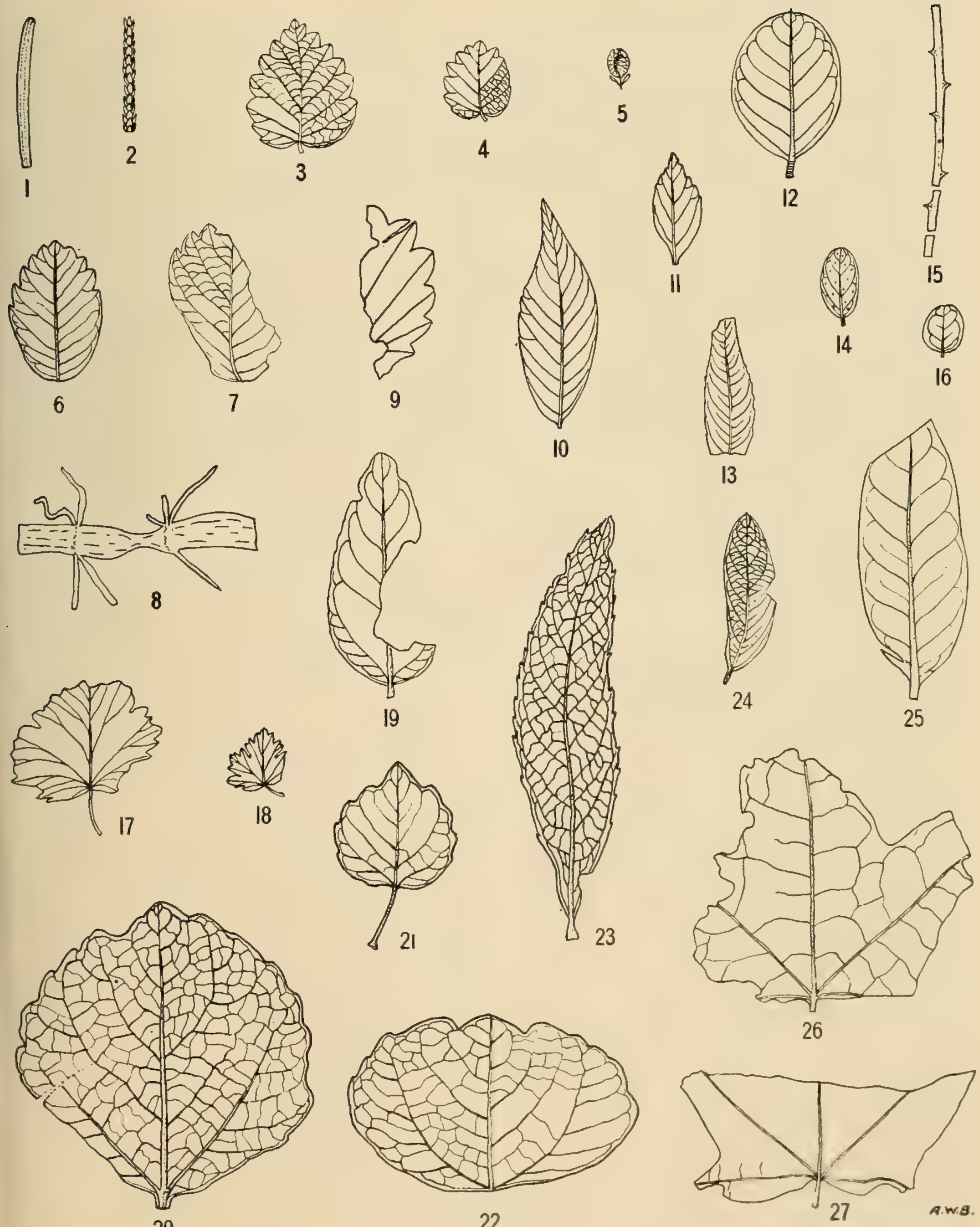

Fig. 1.—Coniferous needle. Fig. 2.—*Juniperus* sp. Figs. 3–5, 9.—*Ulmus venustula* Brown, n. sp. Figs. 6, 7.—*Amelanchier apiculata* Brown, n. sp. Fig. 8.—Grass. Figs. 10–11.—*Rhus salilacualis* Brown, n. sp. Fig. 12.—*Amorpha hesperia* Brown, n. sp. Fig. 13.—*Salix* sp. Fig. 14.—*Amorpha glandulata* Brown, n. sp. Fig. 15.—Spiny stem. Fig. 16.—Unidentified leaf. Figs. 17–18.—*Ribes hyrumense* Brown, n. sp. Fig. 19.—*Populus alexanderi* Dorf. Figs. 20–22.—*Populus pliotremuloides* Axelrod. Fig. 23.—*Salix paradisensis* Brown, n. sp. Fig. 24.—*Salix williamsi* Brown, n. sp. Fig. 25.—Unidentified leaf. Figs. 26–27.—*Acer* sp.

the arroyo willow, *Salix lasiolepis* Bentham, and the silky willow, *S. sitchensis* Sanson, in the living flora and some of the fossil specimens referred to *S. wildcatensis* Axelrod (*3*, p. 132, 341, pl. 58, fig. 2), but the secondary venation of the latter seems to be more open.

The species is named for the collector, Dr. J. Stewart Williams.

Populus alexanderi Dorf Fig. 19

Populus alexanderi Dorf, as synonymized by Condit, Carnegie Inst. Washington Publ. 553: 40. 1944.

This leaf is comparable to small specimens from the living *Populus trichocarpa* Torrey and Gray, a cottonwood widely distributed along streams and washes in the Western States. The small size of *P. alexanderi* is said to differentiate it from the Miocene *P. eotremuloides* Knowlton, whose leaves more nearly approximate the normal leaves of *P. trichocarpa* in size and other features.

Populus pliotremuloides Axelrod Figs. 20–22

Populus pliotremuloides Axelrod, Carnegie Inst. Washington Publ. 476, pt. 3: 169, pl. 4, figs. 1–3. 1937; idem, Publ. 553; 281, pl. 48, fig. 6. 1944. Chaney, idem, Publ. 476, pt. 4: 214, pl. 6, fig. 4; pl. 7, figs. 1c, 1d. 1938.

This species, from a number of Pliocene florules in California and Oregon, is most closely comparable to coarse-toothed variants of the common aspen, *Populus tremuloides* Michaux, which is now found usually at high altitudes across the northern United States and Canada.

ULMACEAE

Ulmus venustula Brown, n. sp. Figs. 3–5, 9

Samara 5 mm long, 3 mm wide, round-ovate in outline, with a relatively narrow membranous wing around the seed. Styles strongly incurved. Pedicel short. Leaves symmetrical, oval-cordate in outline, with large, simple-serrate, mammillate rounded teeth. Secondary veins craspedodrome, only slightly curved or undulate, with branches into the angular sinuses between the teeth. Petioles short.

I find no satisfactory match for the small samara, either among living or fossil species of *Ulmus*. The leaves also remain unmatched, although similar, symmetric, simple-toothed cordate variants may occur on the American elm, *Ulmus americana* Linnaeus, and perhaps other living species. They are not unlike some leaves of species of *Zelkova*. Among fossils they resemble most closely the leaves called *Ulmus moorei* Chaney and Elias (*4*, p. 39, pl. 6, figs. 1–5) from early and middle Pliocene deposits in Oklahoma and Kansas. No samaras were reported from those strata, but one was figured by Dorf (*5*, p. 116, pl. 2, fig. 4) as *U. moorei*, from late Miocene or early Pliocene strata on Hog Creek, 10 miles northwest of Weiser, Idaho, although none of the reported leaves was illustrated. The samara is twice the size of the Utah specimen, and some of the leaves from Oklahoma have a few double-serrate teeth. I conclude, therefore, that, although closely related, the Utah and Oklahoma elms are different species. No native species of elm occurs in Utah today.

SAXIFRAGACEAE

Ribes hyrumense Brown, n. sp. Figs. 17–18

Leaves rounded-orbicular, palmate, 5-lobed, the lobes not deeply incised and the margins with a few rounded teeth. Base squarish to slightly cordate. Petiole of medium length.

The choice between *Physocarpus* and *Ribes* as the genus to which these leaves belong is difficult to make. They can be matched by the leaves of species of both genera now living in the pinyon and aspen belts of Utah, particularly *Physocarpus alternans* (Jones) Howell and *Ribes inebrians* Lindley. Assignment to either genus would not materially affect the compositional aspect of the flora or the conclusion regarding the environmental picture. I lean toward reference to the gooseberries, *Ribes*. Slightly larger but closely comparable leaves occur in the flora from the Creede formation, near Creede, Colo.

ROSACEAE

Amelanchier apiculata Brown, n. sp. Figs. 6, 7

Leaves obovate or elliptic in outline, with notably prominent apexes and with large, rounded, forward-pointing teeth on the apical half of the margin. The secondary veins are distinctly curved, somewhat irregular or undulate, and enter large teeth when these are present. The veinlets connecting the secondaries have a tendency to be horizontal rather than diagonal with respect to the base of the blade.

These leaves are like the small leaves of the western serviceberries, *Amelanchier alnifolia* Nuttall and *A. utahensis* Koehne, when these species live in dry situations. Among fossils the species is perhaps most like *A. alvordensis* Axelrod (*3*, p. 255, pl. 44, fig. 3) from Pliocene strata on Alvord Creek, Oreg., but differs in having more acute apexes.

FABACEAE

Amorpha glandulata Brown, n. sp. Fig. 14

Leaflet small, elliptic, with entire margin, rounded apex without a spine, cuneate-rounded, asymmetric base, and a short glandular petiole. Secondary venation markedly camptodrome. Intersecondaries none. Surface of the blade glandular-punctate.

This species resembles the leadplant, *Amorpha canescens* Pursh, distributed in the Southern and Central States, west to the Rocky Mountains. Among fossils it resembles *Amorpha oblongifolia* Axelrod (*1*, p. 111, pl. 9, figs. 2–4) from the Miocene of the Mohave Desert, Calif., but differs particularly in having punctate glands.

Amorpha hesperia Brown, n. sp. Fig. 12

Leaflet oval to elliptic, with entire margin, rounded apex with spiny tip, cuneate to rounded more or less asymmetrical base, and a short glandular petiole, as shown by the transverse wrinkles. Secondary venation camptodrome, with scarcely distinguishable intersecondaries.

This leaflet can be matched with the smaller leaflets of the indigo bush, *Amorpha fruticosa* Linnaeus, of the Southern and Central States and Canada, west to the Rocky Mountains. Other fossil specimens of *Amorpha* have likewise been compared with *A. fruticosa* and some with *A. californica* Nuttall, but what this means is general resemblance, not absolute identity. In 1944 Chaney (*3*, p. 318, pl. 51, figs. 2–4) described *A. condoni* as a new species in a Pliocene flora from The Dalles region of Oregon. The leaflets of this species, according to the published figures, are dominantly acute at the apexes and therefore excite doubts concerning the identification as *Amorpha*. They resemble those of species of *Sophora* rather closely. Axelrod (*1*, p. 202, pl. 38, fig. 4) identified as *A. condoni* Chaney a specimen from the Pliocene of California, which when compared with the type figures raises considerable doubt of identity. The specimen figured by Axelrod (*3*, p. 260, pl. 45, fig. 9) as *A. condoni* Chaney from the Alvord Creek region of Oregon differs still more from the types and Axelrod's previous specimen but, except for size, compares pretty well with the specimens here figured. Chaney's (*3*, p. 348, pl. 63, figs. 1, 2) *A. condoni* specimens from Troutdale, Oreg., also seem to belong here. If the types of *A. condoni* Chaney are in fact *Sophora* or something else, the other fossils here reviewed that have been assigned to *A. condoni* will require reassignment. However, without the type specimens in hand for more detailed comparisons I am reluctant to propose any synonymies at this time.

ANACARDIACEAE

Rhus salilacualis Brown, n. sp. Figs. 10–11

Leaflets elliptic-lanceolate, asymmetric, widest above the middle of the blade, entire except for a few, low, rounded lateral or apical teeth. Petiole extremely short, if any. Secondary veins numerous, closely spaced, camptodrome, except those that enter the marginal teeth.

These leaflets can be matched fairly closely with leaflets from the dwarf sumac, *Rhus copallina* Linnaeus, which prefers relatively dry situations in the eastern United States and southwest to Texas. No sumac of this description is now native to Utah and the Pacific States.

ACERACEAE

Acer sp. Figs. 26–27

These fragments, which are counterparts, are hardly enough to establish a new species. Restored, the leaf resembles closely the small leaves of the sugar maple, *Acer saccharum* Marshall, of the eastern United States, and those of *A. pictum* Thunberg, of eastern Asia. The base seems much too cordate, the lobes too simple, and the sinuses too shallow for identification of the leaf as representative of *Acer bolanderi* Lesquereux, the common Pliocene maple of California. No seeds have been found to assist in the specific identification of this leaf.

Unidentified Specimens

SPINY STEM Fig. 15

The spines on this slender stem are distinctly deltoid like those on *Rubus* and *Rosa*. The spines or prickles on *Ribes* are generally needlelike rather than deltoid, and, consequently, this stem can hardly be regarded as confirming the identification of the leaves herein called *Ribes hyrumense*.

LEAVES

Fig. 16. This is a small, orbicular leaf with a short petiole and looped secondary venation. It may belong with one of the species of *Amorpha*.

Fig. 25. This lanceolate leaf with camptodrome venation and short petiole is not well enough preserved to yield further clues to its identity. It may represent a species of *Quercus*.

CONCLUSION

Although the identified species listed in this collection are few in number and some purport to be new, the total aspect gives a fair clue to the original environmental setting. The presence of an aspenlike poplar and a possible pine or fir points toward fairly high ground for at least part of the flora. The maple, sumac, gooseberry, serviceberry, indigo bush, and juniper probably lived a little lower behind the streamside species of cottonwood, willow, and grass.

The relatively small size of all the dicotyledonous leaves and the elm samara is so striking that it can hardly be attributed to some special selective action in the transportation of plant debris from its source to the basin of deposition, although, as stated in the introduction probably only the more resistant materials were preserved. I think, rather, that it is reasonable to regard the leaves and fruit as normal, mature products and that their smallness reflects the aspect that vegetation tends to assume under rigorous climatic conditions, whether dry, hot, cold, or some combination of these factors. On this evidence and the fairly close similarity in composition of the fossil flora to that living in the dry foothills of Utah and adjacent States today, there is good reason to conclude that the climate represented by the fossils was semiarid and that the flora lived at a not too remote date. The presence of cottonwoods and willows suggests streams that demanded a fair amount of precipitation, probably at least 15 inches annually. The elm, maple, serviceberry, indigo bush, and sumac support this inference and tend to raise rather than lower the mositure requirement.

The semiarid picture of the fossil climate just drawn leads directly to the practical question, What is the age of the flora? The flora, obviously, was derived from ancestors that either developed in the environs of Cache Valley or migrated into the area from more distant regions. As no other flora of the same age or composition has been found in Utah, fossil collections from neighboring States must be inspected for evidence of its probable origin. To the northwest, across the Utah-Idaho boundary, are outcrops of the Idaho formation, a portion of which may be early Pliocene in age. In the vicinity of Weiser, Idaho, they contain a flora of ferns, conifers, and dicotyledons that indicates an average annual precipitation of about 30 inches, which is somewhat less than that for the moist climate indicated by the antecedent Miocene flora from the Latah formation in Washington and Idaho. However, the only genera common to the flora of the Idaho formation and the flora from Cache Valley are *Juniperus*, *Ulmus*, and *Acer*, and of these, the species of *Ulmus* and *Acer*, at least, do not appear to be identical. The flora from Cache Valley represents an even drier environment than that from the Idaho formation. If, therefore, the trend toward aridity in the northern half of the Great Basin continued without distinguishable relapses from the late Miocene onward, the flora from Cache Valley should be younger than that from Weiser in the Idaho formation.

The strata assigned to the later Pliocene of Idaho have yielded horses and other mammals but no plants of any value for correlation purposes.

The Ogalalla formation of the Pliocene of Colorado and Kansas contains chiefly grass and hackberry seeds. Farther south the early and middle Pliocene deposits on the High Plains of Oklahoma and Kansas contain only one species clearly comparable to another in the flora from Utah, namely, *Ulmus moorei* Chaney and Elias.

The Pliocene floras of California, Oregon, and Nevada, which have been extensively elaborated in recent years, contain, at one locality or another, one or several genera that are also found in the flora from Utah, but I find no close agreement in species and compositional aspect. According to Axelrod (*2*, p. 127, 142) the western middle Pliocene floras reflect a semiarid climate that in general had a pronounced effect on the evolution of local environments and species adapted to them. The derivation of the flora from Cache Valley, therefore, seems to have been from late Miocene and early Pliocene ancestors that by evolution produced species that were adapted to the increasingly arid conditions.

The fresh-water molluscan fauna from strata of the Salt Lake formation, 14 miles northwest of Logan, Utah, according to Yen (*7*, p. 272) indicates Pliocene age, perhaps late Pliocene. The ostracodes from the same locality as the mollusks were studied by Swain (*7*, p. 518), who found the assemblage modern in aspect except for three species whose ornamentation differs considerably from that of living relatives. The insect, fish, and bird remains have not been studied and evaluated.

In summary, the dwarfed, semiarid aspect of the flora from Cache Valley, the resemblance of the flora, with the exception of the extinct elm, to the living flora of Utah and adjoining States, and the evidence from the invertebrates point toward a probable middle to late Pliocene age for the flora.

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ENTOMOLOGY.—*The origin and classification of the trombiculid mites, or Trombiculidae.*[1] H. E. Ewing, collaborator, Bureau of Entomology and Plant Quarantine.

The trombiculid mites, also known as the chigger mites, constitute the family Trombiculidae, a family which is not very well defined. However, the larvae of nearly all its species are peculiar among the members of the superfamily Trombidioidea in that they parasitize vertebrates rather than arthropod invertebrates. These larvae are characterized by progressive degrees of specialization in different directions from the generalized types which have characters linking them to the more generalized adult mites of the suborder Prostigmata.

The active nymphs and adults of trombiculid mites are characterized by nearly always having the abdomen strongly constricted behind the humeral region. In addition different members are structurally adapted for a concealed life usually in the bottom of moist herbaceous growth, in heavy forest litter, in caves, or in loose moist soil.

But little has been suggested as to the origin of trombiculid mites. In fact it has been only in the last few years (chiefly war years) that any extensive knowledge of their diversified structure, biology, and distribution has been attained.

EVOLUTION OR PHYLOGENY

The trombiculid mites and their relatives of such genera as *Tanaupodus* Haller and *Rhinothrombium* Berlese are probably among the most primitive or generalized of all the members of that branch of the suborder Prostigmata known as the thumbed mites

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[1] Received March 2, 1949.

(i.e., mites having the palpal tarsus modified into a subapical thumb). This is particularly indicated by the generalized nature of the larvae of certain species in which the chelicerae show clearly their 2-segmented nature (the fanglike distal segment articulating with the basal segment as it does in the nymphs and adults), the palpi yet showing the palpal trochanter, the lobes of the palpal base (maxilla) yet being free and not forming a collar about the cheliceral fangs, and, finally, by the chaetotaxy of the abdomen, which shows a relatively small number of setae arranged in very definite transverse rows. Larvae with this combination of characters are not found in the insect- or arthropod-infesting species which make up the families of Trombidiidae and Erythraeidae.

For many years the writer had supposed that parasitism among the larvae of most of the thumbed mites must have arisen first with the species that parasitized arthropods, because of the great antiquity of both the mites and the Arthropoda. However, a study of the comparative anatomy of the vertebrate-infesting larvae with that of the arthropod-infesting larvae leaves but little doubt that parasitism arose with the vertebrate-infesting species in the Trombidiidae-Hydrachnidae complex (phalanx Phanerostigmata of Oudemans). The arthropod-infesting species have very highly modified cheliceral fangs, usually an apical rostral collar surrounding the cheliceral fangs, the chaetotaxy of the abdomen greatly modified by the disruption of the orderly arrangement of the setae in transverse rows, and the modification of the legs in many ways. Particularly the tarsi and the tarsal armature become greatly modified in some of these arthropod-infesting forms, the claws being transformed into various shapes, frequently being pectinate, or pectinate-plumose.

Although parasitism among the larvae of the Trombidioidea probably first arose with the parasitization of vertebrates, yet after being long established in this group, which in a broad sense we should call the Trombiculidae, there was some reversion among them, such as André has noted (1943, p. 294) in the case of *Acomatacarus paradoxus* (André), which parasitizes scorpions.

CLASSIFICATION

The trombiculid mites were for many years regarded as a subfamily of the Trombidiidae. The present writer (Ewing, 1944, p. 101) raised this subfamily to the rank of a family which was divided into two subfamilies, the type subfamily and a new subfamily, the Hemitrombiculinae.

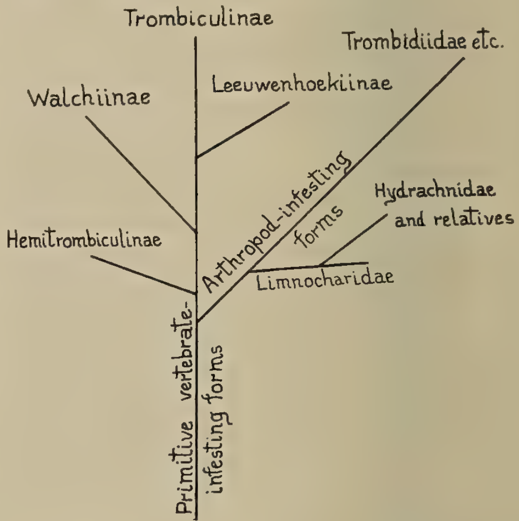
Trombiculinae
Trombidiidae etc.
Walchiinae
Leeuwenhoekiinae
Arthropod-infesting forms
Hydrachnidae and relatives
Hemitrombiculinae
Limnocharidae
Primitive vertebrate-infesting forms

Fig. 1.—Diagram illustrating the suggested origin and relationships of the four subfamilies of Trombiculidae.

Michener (1946a, p. 349) has objected to such a change. He states: "Incidentally, it does not seem justifiable to recognize the latter group [Trombiculinae] as a separate family as has recently been done, especially when the other nine subfamilies are not also raised to family rank. It is far more logical to expand and enrich the classification by the use of subfamily and tribal names than by elevating each slightly distinct group to the family status." The answer to this thesis of Michener is that these groups are *not all* "slightly distinct groups" and that the trombiculid mites differ very much from the others in their biology and to a certain degree in their distribution.

Womersley (1945, p. 96) on the other hand not only recognizes the family Trombiculidae but has raised one of its subfamilies, his Leeuwenhoekiinae, to the rank of a family.

The classification here given is an extension and modification of the key to the four recognized subfamilies published in 1946

(Ewing, 1946, p. 435). It should be noted, however, that the four subfamilies recognized in 1946 are not equally distinct. The division between the Trombiculinae and the Leeuwenhoekiinae is not sharp, and is made in a somewhat different manner, as indicated in the key to the subfamilies farther on. This is due to the description of a new genus by Wharton (1947, p. 380) who, when describing the same, proposed an interesting new arrangement of the subfamilies of the Trombiculidae based on the number of segments in the legs.

The subfamilies Hemitrombiculinae and Walchiinae are very distinct and stand apart more or less from the rest of the Trombiculidae. In fact, the Hemitrombiculinae could be made a separate family between the Trombiculidae and the water mites of the family Limnocharidae. To regard the Hemitrombiculinae as water mites is not in accord either with their anatomy or habits and contrary to the indicated course of evolution.

TERMINOLOGY—NEW AND SOME OLD TERMS DEFINED

Most of the terms used in the taxonomy of the trombiculid mites are rather well known and understood. A few are here introduced for the first time. These, together with some of the older terms, are here defined.

Capitulum (Fig. 2, *cap.*): The most anterior division of the body, being that part which bears the mouth parts plus the region anterior to them. Gnathosoma, a term suggested by Oudemans for this part of the acarine body, has been employed to some extent by certain workers. However, there are two objections to its use. It is misleading in its implication for it is applied not only to the segments bearing the mouth parts but to the one (or two) in front of them. Also, if it were used to designate exclusively the segments bearing the mouth parts, it would not be equivalent to the gnathosoma of Insecta.

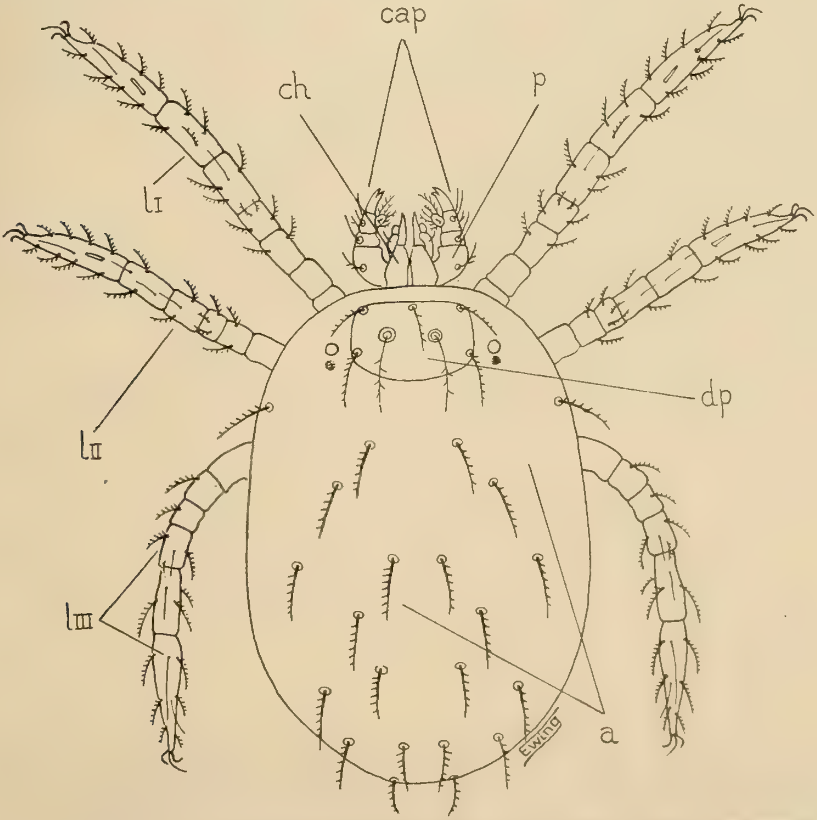

FIG. 2.—Larva of *Trombicula alfreddugèsi* (Oudemans), dorsal view greatly enlarged with larger parts labeled: *a*, Abdomen; *cap*. capitulum; *ch.*, chelicera; *d.p.*, dorsal plate; *l.I.*, leg one; *l. II*, leg two; *l. III*, leg three; *p.*, palpus.

Distal segment of chelicera (= *piercing element of chelicera* = *fang of chelicera*) (Fig. 3, *d.s.*): The distal segment of the 2-segmented chelicera. In the larvae of the Trombiculidae it usually is adapted to piercing and holding fast to the skin of the host.

Pseudochela: A dorsal, hyaline process arising from the base of the distal segment of the chelicera and extending forward above the cheliceral blade.

Palpal trochanter (Fig. 4, *p. tr.*): The first segment of the functional palpus, the coxa having been transferred to and fused with the capitular sternum. In many genera the palpal trochanter is partly or even completely fused with the palpal femur. Usually it is separated from the palpal femur by a distinct and true suture.

Axial prong of palpal claw (Fig. 4, *a.p.*): The chief prong, or, more specifically, the one that lies in the axis of the claw base.

Accessory prongs of palpal claw (Fig. 4, *ac. p.*): Other prongs than the axial prong.

Pseudostigmatic organs (Fig. 5, *ps. o.*): Paired specialized sensory setae of a particular type. Each is situated in a funnel-like dermal pit on the dorsum of the cephalothorax. Their number and form are of much phylogenetic importance.

Sensory seta: A sensillum (= sensilla of many authors) having its cuticular part in the form of a seta. As usually applied in the study of chiggers it is preferable to the more inclusive term sensillum (= sensilla) which may also apply equally well to sensory organs having no setalike cuticular part.

Slitlike dermal pores (Fig. 5, *d.p.*): Slits in the dermal plate either in front of or behind, or both in front of and behind, each pseudostigma.

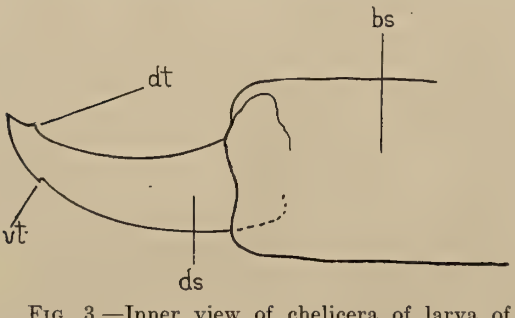

Fig. 3.—Inner view of chelicera of larva of *Eutrombicula alfreddugèsi* (Oudemans), with parts labeled: *b.s.*, Basal segment; *d.s.*, distal segment; *d.t.*, dorsal tooth of distal segment; *v.t.*, ventral tooth of same.

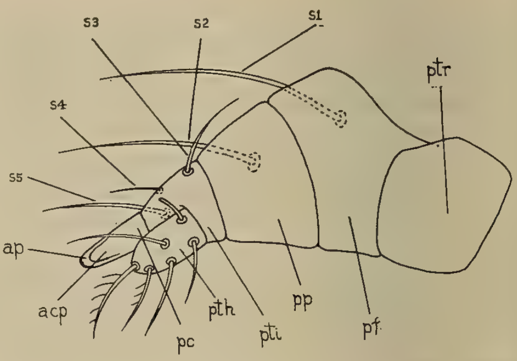

Fig. 4.—Ventral view of palpus of *Gahrliepia nana* (Oudemans), a generalized type of palpus in which the palpal trochanter is free and unreduced: *ac. p.*, Accessory prong of palpal claw; *a.p.*, axial prong of palpal claw; *p.c.*, palpal claw; *p.f.*, palpal femur; *p.p.*, palpal patella; *p. th.*, palpal thumb; *p. ti.*, palpal tibia; *p. tr.*, palpal trochanter; *s. 1*, seta one; *s. 2*, seta two; *s. 3*, seta three; *s. 4*, seta four; *s. 5*, seta five. (Adapted from Oudemans.)

Bilaterally plumose: A term applied to a plumose seta with branches in a single plane and on both sides of the shaft.

Unilaterally plumose: A term applied to a plumose seta with branches in a single plane and on one side of the shaft.

Evenly rounded: Rounded like the arc of a circle.

Unevenly rounded: Rounded, but not like that of an arc of a circle.

Humeral setae (= setae of the first row of two on dorsum of the abdomen, of most authors): The pair of setae situated in the

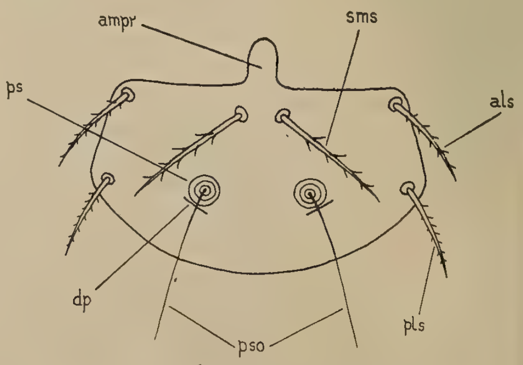

Fig. 5.—Dorsal plate of larva of *Comatacarus americanus* Ewing: *al.s.*, Anterolateral seta; *a.m. pr.*, anterior median process; *d.p.*, slitlike dermal pore; *pl.s.*, posterolateral seta; *ps.*, pseudostigma; *ps.o.*, pseudostigmatic organs; *sm.s.*, submedian seta.

anterolateral corners of the dorsum of the abdomen. They represent the displaced laterals of the true first row, and in a few species occupy their primitive position in this row. In formulae for the arrangement of the setae of the dorsum some authors have given the humeral setae, regardless of their position, as belonging to what most authors regard as the second row.

Capitular sternum (= *maxilla*, less palpal coxae): The sclerotized venter of the capitulum, without the fused palpal coxae.

Palpal base (= *maxilla*) (Fig. 6, *p.b.*): The capitular sternum plus the fused palpal coxae.

Outer lobes of palpal base (= *outer maxillary lobes*) (Fig. 6, *o.l.p.b.*): The outer pair of upcurved and usually incurved lobes of the palpal base. They nearly always bear a pair of setae and in most arthropod-parasitizing larvae they are modified to form a rostral collar.

Inner lobes of palpal base (= *inner maxillary lobes*) (Fig. 6, *u.l.p.b.*): The inner membranous pair of lobes of palpal base. They are wanting in some genera and bear no setae.

Rostral collar: The collar formed by the approximation or fusion dorsally of the outer lobes of the palpal base. Through this collar the piercing parts of the chelicerae protrude. The rostral collar is present in but few genera of the Trombiculidae and then is rather poorly formed. It is a structure correlated with the attachment of the cheliceral fangs or hooks to the sclerotized integument of arthropods.

Interpalpal setae (= *maxillary setae*) (Fig

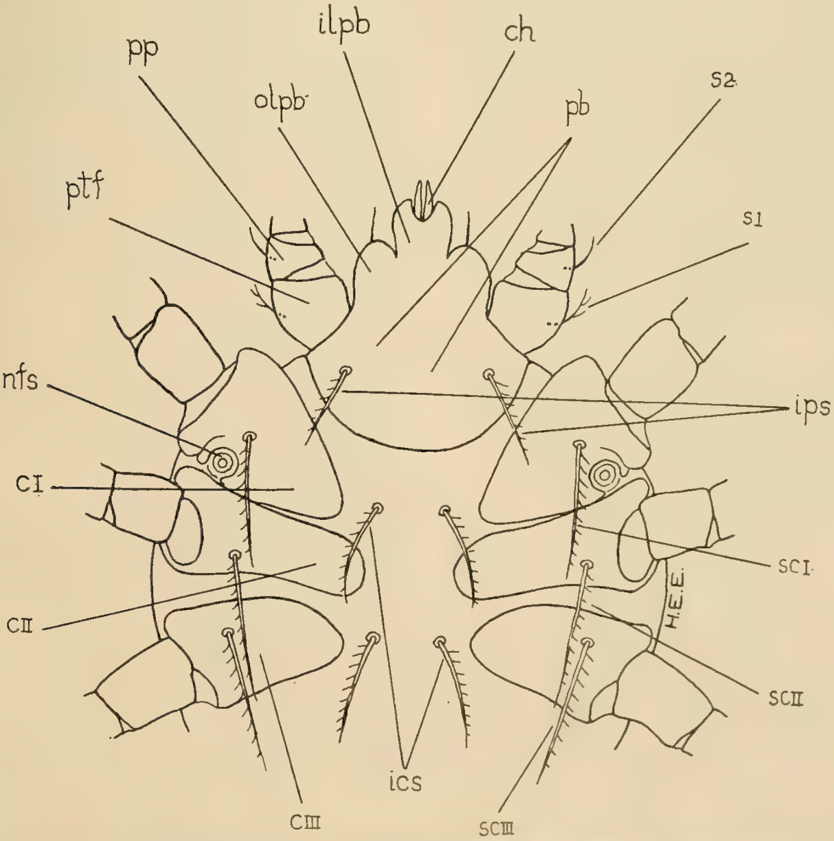

Fig. 6.—Ventral view of body of larva of *Trombicula autumnalis* (Shaw) (adapted in part from Hirst and from André): *Ch.*, Chelicera; *c.I.*, coxa one; *c.II*, coxa two; *c.III*, coxa three; *ic.s.*, intercoxal setae; *i.l.p.b.*, inner lobe of palpal base; *ip. s.*, interpalpal setae; *nf. s.*, nonfunctional spiracle; *o.l.p.b.*, outer lobe of palpal base; *p.b.*, palpal base (maxilla); *p. p.*, palpal patella; *p. tf.*, palpal trochanterofemur; *s. 1*, seta one of palpus; *s. 2*, seta two of palpus; *s.c.I.*, seta of coxa one; *s.c.II*, seta of coxa two; *s.c.III*, seta of coxa three.

6, *ip. s.*): The pair of setae situated on the palpal base between the two palpi. They apparently are the coxal setae of the palpi, and have been transferred to the palpal base by the fusion of the palpal coxae with the capitular sternum.

Intercoxal area (= *sternal area*): The venter of the cephalothorax between the coxae. Since trombiculid larvae have no sternum it appears improper to speak of the area between the coxae as the sternal area.

Intercoxal setae (Fig. 6, *ic. s.*): One or more pairs of cephalothoracic setae situated in the intercoxal area.

A DESCRIPTION OF THE FAMILY TROMBICULIDAE

A formal description of the family Trombiculidae Ewing based on larval characters is here given.

Larvae.—The larvae vary from about 0.2 mm to 0.35 mm in length before engorgement and usually are reddish in color but may be orange, yellowish, cream colored, or white. *Chelicera* usually showing its 2-segmented condition, the distal segment being bladelike or styliform. *Palpi* stout; palpal coxae fused with capitular sternum to form palpal base (maxilla), which is divided in front into one or two pairs of lobes. Palpal trochanter either distinct or fused with palpal femur; palpal femur enlarged, rounded or angulate laterally; palpal patella large; palpal tibia bearing apically a stout, curved claw, usually divided into prongs; palpal tarsus a seta-bearing thumb. *Cephalothorax* not demarcated from abdomen and all its dorsal setae typically borne by a single dorsal, median plate. A single pair of pseudostigmata and pseudostigmatic organs present, except in *Hemitrombicula*. Eyes present or absent; when present, sessile and usually two on a side. Ventrally cephalothorax without sternum or sternal rods but bears the platelike coxae, and from one to three pairs of intercoxal setae. *Functional spiracles* present or absent; when present a single pair situated laterally in front of first pair of coxae. Vestigial, nonfunctional spiracles situated between first and second coxae, but usually associated with first coxae. *Abdomen* almost circular except when distended due to feeding, then oblong. Abdominal setae in more generalized forms not numerous and in definite transverse rows, but becoming very numerous and disrupted from orderly arrangement in certain specialized species. No median plate on abdomen except in *Guntherana*, where it is posterodorsal and may be divided. *Legs* of moderate length and stoutness, 6- or 7-segmented; when 7-segmented the femur has become divided according to some authors. Segments of legs not greatly swollen and clothed chiefly with the usual curved setae, but some spines and long tactile setae also present. Tarsal armature typically consisting of three simple claws; in some cases only two claws present.

Type genus.—*Trombicula* Berlese, 1905.

Remarks.—The type genus is based on adults, but it is assumed that the larvae when reared will be found to have larval characters somewhat similar to the known larvae of adults closely related to those of the type species.

The family Trombiculidae as here defined does not include species having two pairs of pseudostigmata with their pseudostigmatic organs or more than one median shield on the anterior part of the dorsum. Oudemans (1912, p. 86) placed his genus *Rohaultia* (now by synonymy *Johnstoniana* George) which included a single species with two pairs of pseudostigmata and pseudostigmatic organs, next to the genera *Hannemania*, *Leeuwenhoekia*, and *Heterothrombidium*. In this genus the tarsi are 2-clawed and, in part for this reason, he regarded it as being a connecting link between these genera and the water mite genus *Limnochares*. However, it hardly serves this purpose as well as *Hemitrombicula*.

The genus *Blankaartia* Oudemans, in which there are two median dorsal plates, has been placed by some authors in the Trombiculidae. This has been done because of the belief, apparently in error, that the larvae on which the generic characters were based were those of trombiculid adults of a species with which they were associated in nature.

The family Trombiculidae has already (Ewing, 1946, p. 435) been divided into four subfamilies. As characters for this division the chaetotaxy of the dorsal plate, the presence or absence of the tracheae and functional spiracles, the presence or absence of true pseudostigmatic organs, and the nature of the tarsal claws and the body setae were used. To these characters, that of segmentation of the legs is here added.

CLASSIFICATION OF THE SUPERGENERIC GROUPS OF TROMBICULIDAE BASED ON LARVAL CHARACTERS

A. Dorsal plate without either median or submedian setae and without anterior median process; tracheae and functional spiracles absent.

  B. Pseudostigmatic organs represented by unmodified, simple setae; tarsi two-clawed; body setae simple
  Hemitrombiculinae Ewing
  Genus: *Hemitrombicula* Ewing

  BB. Pseudostigmatic organs true sensory setae; tarsi three-clawed but one or two claws frequently much reduced; body setae barbed or branched. . Walchiinae Ewing
  Genera: *Walchia* Ewing
  Schöngastiella Hirst
  Gahrliepia Oudemans
  Gateria Ewing

AA. Dorsal plate with either a median seta or a pair of submedian setae on or near anterior margin and frequently with an anterior median process; tracheae and functional spiracles frequently present.

  B. Dorsal plate without median seta but with two submedian setae; all legs six-segmented; tracheae and functional spiracles nearly always present
  Leeuwenhoekiinae Womersley

    C. Tracheae and functional spiracles present; distal segment of chelicera without pseudochela; tarsi three-clawed. . . . . . Division Tracheata
    Genera: *Hannemania* Oudemans
    Whartonia Ewing
    Leeuwenhoekia Oudemans
    Acomatacarus Ewing
    Comatacarus Ewing

    CC. Trachea and functional spiracles absent; distal segment of chelicera with a dorsal, hyaline process, the pseudochela, which extends almost to tip of cheliceral blade; tarsi either two-clawed or three-clawed
    Division Atracheata
    Genus: *Chatia* Brennan

  BB. Dorsal plate with a median seta, except in *Apolonia* in which genus all legs are seven-segmented; tracheae and functional spiracles usually absent
  Trombiculinae Ewing

    C. Tracheae and functional spiracles present; dorsal plate usually with an anterior, median process
    Division Tracheata
    Genera: *Apolonia* Torres and Braga
    Womersia Wharton
    Odontacarus Ewing

    CC. Trachea and functional spiracles absent; dorsal plate never with a true anterior, median process, but may be outwardly rounded at median line. . Division Atracheata (contains four sections)

      D. Distal segment of chelicera adapted for piercing or cutting; palpi seldom bent inward as if for clasping.

        E. Middle tarsal claw not stouter than paired claws; eyes nearly always present.

          F. Pseudostigmatic organs usually clavate or capitate never setiform or flagelliform. . . . . Section I
          Genera: *Schöngastia* Oudemans
          Endotrombicula Ewing
          Oenoschöngastia Womersley and Kohls
          Neoschöngastia Ewing
          Ascoschöngastia Ewing
          Euschöngastia Ewing
          Doloisia Oudemans
          Guntherana Womersley and Heaslip

          FF. Pseudostigmatic organs setiform or flagelliform, and with or without barbs or lateral branches
          Section II
          Genera: *Heaslipia* Ewing
          Novotrombicula Womersley and Kohls
          Crotiscus Ewing
          Fonsecia Radford
          Trombiculindus Radford
          Trombicula Berlese
          (With three subgenera; see pp. 235–236)
          Eutrombicula Ewing
          (With two subgenera; see p. 236)
          Tecomatlana Hoffmann

        EE. Middle tarsal claw stouter than paired claws; eyes absent
        Section III
        Genus: *Riedlinia* Oudemans

      DD. Distal segment of chelicera not adapted for piercing or cutting but blunt and with two, large, toothlike processes; palpi strongly bent inward as if for clasping. . . . . Section IV
      Genus: *Myotrombicula* Womersley and Heaslip

NOTES ON THE TAXONOMY OF CERTAIN GENERA OF TROMBICULIDAE

The genus *Trombicula* Berlese is based on a species known only in the adult stage, hence its subgenera are here separated in a key using adult characters. Key to the subgenera of *Trombicula*:

A. Eyes well developed and situated far in front of area sensilligera; palpal tibia slender, about three times as long as broad; large trombiculids occurring in tropical or subtropical regions of both hemispheres
Subgenus *Pentagonella* Thor

AA. Eyes usually poorly developed or absent, when present not situated in front of area sensilligera; palpal tibia short, robust, not three times as long as broad. Usually medium to small trombiculids.

B. Palpal claw truncate apically; pseudostigmata greatly enlarged, each being more than one half width of area sensilligera in diameter. Contains only a single, small species taken in Java
Subgenus *Trombicula* Berlese

BB. Palpal claw not truncate; pseudostigmata not greatly enlarged, never more than a small fraction of width of area sensilligera in diameter. Species found in many parts of the world
Subgenus *Leptotrombidium* Nagayo et al.

Recent rearing experiments have shown that the adults of the genera *Eutrombicula* Ewing and *Acariscus* Ewing are very close together hence the latter genus is here reduced to a subgenus. Key to the two subgenera of *Eutrombicula* Ewing based on larval characters follows:

Dorsal abdominal setae twenty-two (counting posterior marginals and dorsolaterals of row IV) and in unengorged larvae arranged, 2-6-6-4-2-2; ventral abdominal setae of row I, six, middle pair being anterior to others; dorsal plate broader than long and with posterior margin broadly outcurved
Subgenus *Eutrombicula* Ewing

Dorsal abdominal setae more than twenty-two and with different formula; dorsal plate variously shaped........Subgenus *Acariscus* Ewing

In the key to the genera of trombiculids given by the writer (Ewing, 1945 (1944), p. 346) the genus *Endotrombicula* Ewing was given under a category description which stated "Pseudostigmatic organs setiform or flagelliform. . . ." This statement was in accord with the description of the type species of the genus which evidently was made from specimens in which the distal part of these organs was broken off. Now Dr. H. S. Fuller writes in a letter to the author that he has obtained additional material of the type species, *E. penetrans* Ewing, taken from the same individual frog that the type specimens came from. Concerning these he states: "On one of my specimens, the complete pseudostigmatic organ is in place and intact, and it is clavate." Thus *Endotrombicula* has characters similar to those of certain species of *Schöngastia* and these *Schöngastia* species should be transferred to the redefined genus *Endotrombicula*. *Endotrombicula* may be separated from *Schöngastia* as follows:

Piercing part of chelicera with small to minute teeth of a varying number; median seta of dorsal plate barbed or plumose; not parasitic on frogs
Schöngastia Oudemans

Piercing part of chelicera with three or four conspicuous teeth or toothlike processes which increase in size with their distance from the apex; median seta of dorsal plate simple or with vestigial barbs; parasitic on frogs
Endotrombicula Ewing

The relationship of the members of the genus *Acomatacarus* Ewing to those of the subfamily Microtrombidiinae has been clearly indicated by the recent rearing of the nymphs of three species of the former group. Nymphs of two of these species were reared by Maj. G. M. Kohls and of the other species by Lt. Col. C. B. Philip. These nymphs have been described by Womersley (1945) and are remarkable for not having the abdomen constricted and in this respect differing from the nymphs and adults of other trombiculids. This characteristic, as well as the shape and dimensions of the leg segments and the setose clothing of the body, are so nearly those of the adults of the subfamily Microtrombidiinae that Womersley transferred to *Acomatacarus* three species known only in the adult stage that had formerly been placed in the Microtrombidiinae.

Pentagonella Thor, is here regarded as a subgenus of *Trombicula*, and is considered as having as a synonym *Megatrombicula*, established as a subgenus of *Trombicula* by Michener (1946b, p. 432). Michener reported on rearing experiments which certainly show that the adults in this subgenus are very similar to those described by Berlese (1912, p. 96) under the name of *Blankaartia nilotica* (Trägårdh). These adults are of particular interest. According to Berlese (1912, p. 98) the position of the eyes in them indicates a connection with *Microtrombidium* Haller. That *Pentagonella* is to be regarded as possibly being a generalized type is indicated by the large number of subapical spines on the palpal tibia of the adult. On the other hand, the fact that at least one species lays its eggs in masses, as shown by Michener, would indicate a relationship with the more specialized genera in which the larvae are parasitic on arthropods. The larvae of *Pentagonella* are much like those of the different members of *Trombicula* and therefore are not of a specialized type.

Speotrombicula Ewing, a genus based exclusively on adults, contains but a single, peculiar cave species which evidently is specialized for its life in a cave environment. This species is blind and has the front pair of legs adapted especially for crawling and climbing by being much enlarged, sclerotized and provided with trifurcate claws. Members of *Speotrombicula* are very large (length, 2.7 mm) being even larger than the members of the subgenus *Pentagonella* Thor of the genus *Trombicula*. The affinities of *Speotrombicula* are not clear, and probably will remain so until the larval stage of its single species is known.

ACKNOWLEDGMENTS

In the preparation of this paper the writer has been aided especially by three of his colleagues of the Bureau of Entomology and Plant Quarantine: R. E. Snodgrass assisted in the selection of technical terms used; C. F. W. Muesebeck encouraged the work in various ways; and E. W. Baker aided greatly in the study of specimens and in various other ways. Recently Snodgrass (1948) has published an important paper on *The feeding organs of Arachnida, including mites and ticks*. This work proved to be of much value in interpreting the mouthparts of mites.

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ZOOLOGY.—*Chalcogorgiinae, a new subfamily of Chrysogorgiidae (Coelenterata: Alcyonaria), and a description of* Chalcogorgia pellucida, *new genus and new species, from the Straits of Florida.*[1]

FREDERICK M. BAYER, U. S. National Museum. (Communicated by FENNER A. CHACE, JR.)

The early cruises of the U. S. Fish Commission steamer *Albatross* resulted in large collections of interesting and unusual deep-sea invertebrates, many of which for want of interested specialists have found their way to the deepest recesses of the "miscellaneous unidentified" section of the National Museum collections. This is especially true of the less conspicuous creatures, a category into which many of the alcyonarian corals fall without effort. Among these neglected creatures is a chrysogorgiid so unusual that it seems remarkable it should have remained unnoticed until now. Its characters are so divergent from the ordinary that I am here establishing for it a new subfamily as well as a new genus and species.

The family Chrysogorgiidae was established by Verrill in 1883 (p. 21) to include *Chrysogorgia*, *Dasygorgia* (=*Chrysogorgia*), and *Iridogorgia* and was placed between the Ceratoisidae (=Isididae) and the Primnoidae. Verrill saw in its lustrous, calcified axis an alliance to the Primnoidae, and in the sharp demarcation of its calcareous base from the less calcareous stem a possible relationship to the Isididae. Hickson, one of the foremost students of the Alcyonaria, saw it as "a family without any well-defined characters" (1930, p. 250), a view which is difficult to understand. It has been studied in detail only by Versluys (1902), who put the family in excellent order as of his time. He divided the Chrysogorgiidae into three subfamilies: the Lepidogorgiinae for *Lepidogorgia* (now = Radicipedinae for *Radicipes*); the Chrysogorgiinae for *Chrysogorgia, Metallogorgia,* and *Iridogorgia*; and the Riiseinae for *Riisea* and *Pleurogorgia.* At the time of its proposal, it was a convenient arrangement which provided for all the genera then known, but subsequently described species in several genera have again made the classification inadequate. In its zooidal arrangement and manner of branching, *Trichogorgia* Hickson seems to fall into none of Versluys's subfamilies, although in certain respects it approaches closest to the Chrysogorgiinae. *Pleurogorgia militaris* Nutting appears to resemble *Pleurogorgia plana* Versluys (the genotype) only in its manner of branching, while other features indicate a relationship to *Iridogorgia.* For the time being it is probably best to place *Trichogorgia* in the Chrysogorgiinae and permit the Pleurogorgiae to occupy the same subfamily despite their differences. The new subfamily, the fourth, contains at present only one genus and species, from the Straits of Florida. The characteristics of this singular new species definitely corroborate Verrill's belief that the family Chrysogorgiidae is related to the Primnoidae. Since its basal disk is not more calcareous than is the stem, and is not conspicuously jointed to it, the species does nothing to strengthen the theory of relationship with the Isididae. On the other hand, the character of the spicules in *Riisea* indicates a closer relationship of the chrysogorgiids with the Gorgonellidae. Unfortunately for this theory, certain of the isidids exhibit in their spiculation a striking similarity to members of the Chrysogorgiidae. The most recent arrangement (Hickson, 1930, p. 250; Stiasny, 1937, p. 135) places the family at the end of the Holaxonia, with which I can not agree. It is not, however, my purpose to revise the classification of the Chrysogorgiidae or to theorize as to its possible relationship to other families, but merely to provide a place for the unique form described in the following paragraphs.

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received March 2, 1949.

Family Chrysogorgiidae Verrill

Chalcogorgiinae, n. subfam.

Unbranched chrysogorgiids arising from a spreading basal disk; axis partially calcified, and having metallic lustre; zooids biserially arranged; distal zooidal scales broad, folding over the oral disk as a well-formed operculum; sclerites typical double plates with rounded ends, and in the zooids large, irregularly lobed plates.

Chalcogorgia, n. gen.

Colony unbranched, arising from a spreading basal disk which is not more heavily calcified than the axis with which it is continuous; axis partially calcified, with noticeable bronzy iridescence; zooids biserially arranged; distal spicules of the zooids forming a definite operculum which folds down almost flat over the mouth and retracted tentacles; tentacles without spicules; sclerites of the zooid body large, lobate overlapping scales; coenenchyma packed with elongate, flat scales having rounded ends and a median constriction.

The name is derived from the Greek χαλκός = bronze, + gorgia.

Genotype.—Chalcogorgia pellucida.

Chalcogorgia pellucida, n. sp.

The whiplike colony is 130 mm high, arising from a basal disk almost surrounding a small bit of rock (Fig. 1, *c*). The axis is partially calcified but rather flexible and exhibits a beautiful metallic luster. At a point 4 cm from the base it is 0.3 mm in diameter, at 7 cm it is 0.25 mm, and at the apex it is drawn out to an exceedingly fine point. At approximately 7 mm above the base a single row of zooids begins on each side of the stem (Fig. 1, *a*), the members of the two rows being either opposite or alternate to each other. Zooids (Fig. 1, *b*) 1.5–2.0 mm long, directed distally and adherent to the stem. They are unique among the Chrysogorgiidae in possessing a well-developed operculum consisting of eight triangular scales (Fig. 1, *k–n*)

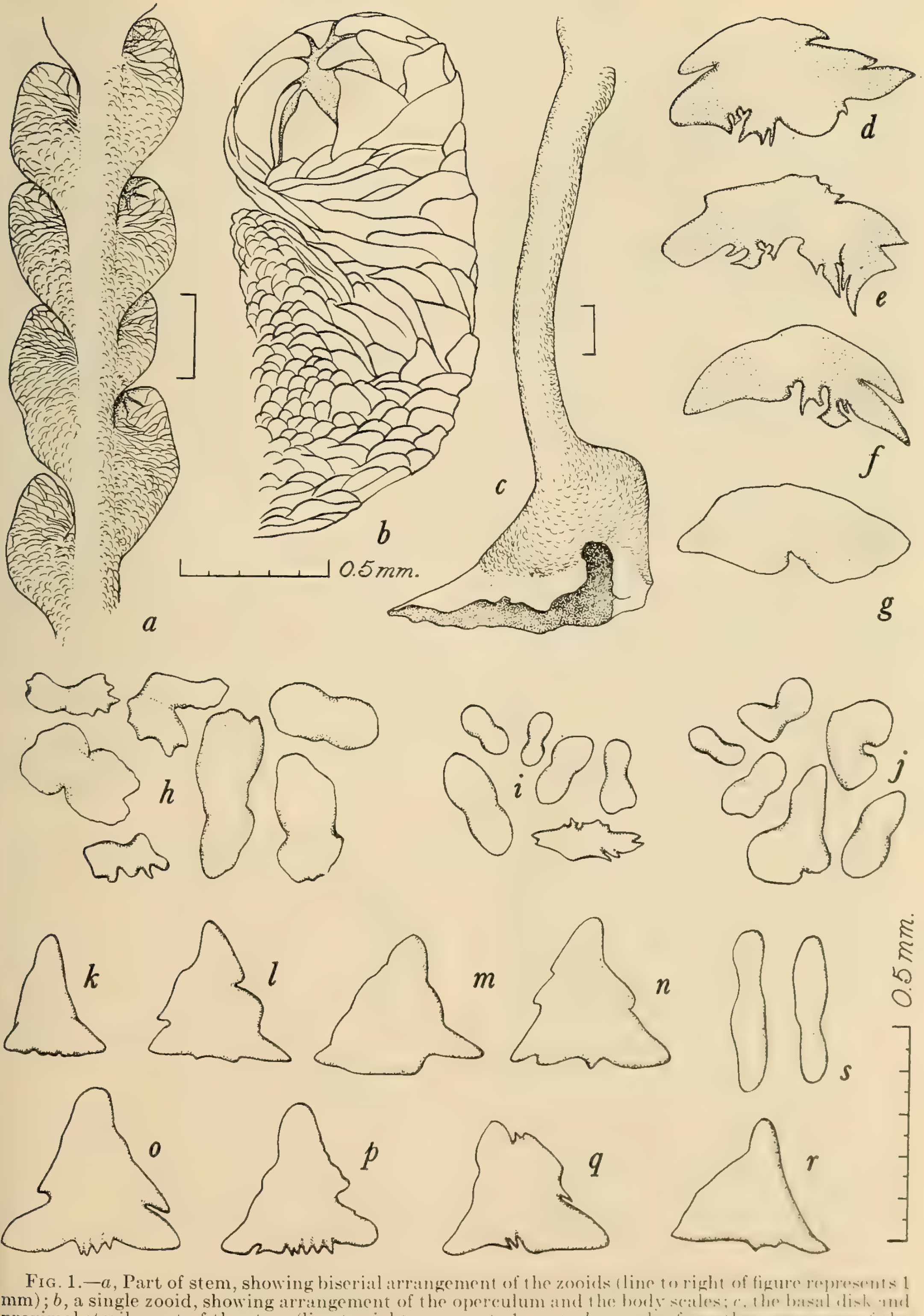

FIG. 1.—*a*, Part of stem, showing biserial arrangement of the zooids (line to right of figure represents 1 mm); *b*, a single zooid, showing arrangement of the operculum and the body scales; *c*, the basal disk and proximal sterile part of the stem (line to right represents 1 mm); *d–g*, scales from the upper part of the zooid body (scale at lower right corner of plate applies to all spicules); *h*, spicules of the coenenchyma, about the middle of the stem; *i*, spicules from the basal part of the zooid; *j*, spicules of the basal disk; *k–r*, the opercular scales; *s*, accessory rods of the operculum.

and a few accessory rods (Fig. 1, *s*). The tentacles, pinnules, and pharyngeal region are devoid of sclerites. The spicules of the zooid body are glassy, irregularly lobed, elongate scales (Fig. 1, *d–g*) transversely arranged, conforming to the curvature of the body, and overlapping one another in a proximal-distal direction. Toward the zooid base the spicules decrease in size, become typical double plates (Fig. 1, *i*) and merge imperceptibly into those of the coenenchyma (Fig. 1, *h*), most of which are double plates with rounded ends and constricted middle, of the sort found in many species of *Chrysogorgia*, *Metallogorgia*, *Pleurogorgia*, and *Trichogorgia*. The spicules of the basal disk (Fig. 1, *j*) are similar but slightly smaller, thicker, and more regular in outline.

Color, in alcohol, very pale brown; spicules colorless.

Type.—U.S.N.M. no. 44220.

Type locality.—2.5 miles northwest of Havana Light, north coast of Cuba, in 387 fathoms. *Albatross* station 2152, April 30, 1884.

Remarks.—This species differs from members of the genus *Radicipes*, which are also unbranched, in the regular biserial arrangement of the zooids, in spiculation, and in the presence of an operculum. It represents a trend toward the primnoid type, and the superficial resemblance it bears to a *Primnoella* is nothing short of remarkable. In spiculation of the coenenchyma, however, it is typically chrysogorgiid.

KEY TO THE GENERA OF THE CHRYSOGORGIIDAE

- *I.* Colony unbranched:
  - *A.* Zooids uniserial; distal zooid spicules not forming an operculum: Genus *Radicipes* Stearns.
  - *B.* Zooids biserial; distal zooid spicules forming an operculum: Genus *Chalcogorgia*, new.
- *II.* Colony branched:
  - *A.* Spicules including many double clubs: Genus *Riisea* Duchassaing and Michelotti.
  - *B.* Spicules including rods, spindles, scales, and irregular forms, but never double clubs:
    - *1.* Branching dichotomous beyond main stem:
      - *a.* Main stem sympodial, giving off branches in a spiral around stem: Genus *Chrysogorgia* Duchassaing and Michelotti[2]
      - *b.* Main stem monopodial, branches arising irregularly near its apex: Genus *Metallogorgia* Versluys.
    - *2.* Branching unilateral:
      - *a.* Main stem spirally coiled or spirally twisted, giving off simple branches from its outside: Genus *Iridogorgia* Verrill.
      - *b.* Main stem straight, branchlets simple: Genus *Pleurogorgia* Versluys.
    - *3.* Branching irregular, terminal branches long, slender, whiplike, arising on upper-part of stem: Genus *Trichogorgia* Hickson.

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[2] The spiral arrangement is obscure or irregular in some species, but there is never a long monopodial main stem.

ZOOLOGY.—*New millipeds of the spiroboloid genus* Watichelus *from the Pacific coast.*[1] H. F. Loomis, Coconut Grove, Fla.

The Southwestern United States and nearby Mexico are the home of a large family of spiroboloid millipeds, the Atopetholidae, most species of which have become known in the past 30 years. They appear to be extremely localized, and each suitable locality may have one or more representatives differing from all others. The rigors of climate in this usually arid region are such that migration of humus inhabitants from one section to another often is difficult and possible only at rare intervals if at all. This isolation of localities has caused "island faunas" of millipeds to develop and accounts for the large number of species of certain genera in several families there today. The new forms here described, combined with the genotype, furnish an excellent example of the development of multiple species in a limited area for all have come from small parts of the three southern counties in California and a small adjacent area in Lower California.

Type and paratype specimens of the species here described have been deposited in the U. S. National Museum.

Watichelus robustus, n. sp.

Specimens collected at Chula Vista, Calif., May 31, 1917 (female), by H. F. Loomis; January 23, 1921 (male type and female), by O. F. Cook; December 1921 (male and female) by C. G. Marshall.

Description.—Length 45 to 50 mm, diameter 6 to 7 mm, the females stouter than the males. Number of segments 40 to 42.

Color in alcohol chestnut-brown, the posterior subsegments darker except the margins, which are nearly colorless and transparent.

Head with the frontal groove long, the one on the vertex short and indistinct; a conspicuous transverse furrow above the clypeus on each side; the obliquely transverse striations of the front moderately deep; clypeal punctures 5-5; eye patch subtriangular and with about 30 ocelli arranged in seven longitudinal rows.

First segment slightly wider than segments immediately following, a distinct median emargination in front and with anterior and posterior lateral emarginations shallow but evident; lateral angles long and slender but not strongly curved caudad; a marginal groove extending from near the apex of the angle beyond the anterior lateral emargination but not reaching behind the eye; surface feebly and irregularly striate and minutely punctate.

Segment 2 with the anteroventral margin rather thick and slightly raised.

Segment 3 with the ventral crest abruptly raised on the outer side, high and moderately long.

On following segments the forebelt has numerous closely placed transverse striae; midbelt very slightly convex, noticeably aciculated and with a very few punctations; hindbelt smoother and somewhat more shining than midbelt, faintly aciculated and punctate; transverse constriction shallow, the surface behind it slightly and evenly convex, not rising abruptly; dorsal median sulcus very faint, evident on the hindbelt only; pore somewhat removed in front of the constriction and followed by a sulcus on the hindbelt; ventral striations deeply impressed, the ridges between them, on the third quarter of the body, produced into strong marginal teeth.

Last segment hardly as long as the three preceding segments, the last two of which are strongly telescoped; apex rounded and with the transverse median impression faint or lacking.

Anal valves not strongly swollen, noticeably flattened behind along the margins which are but slightly depressed; surface with very coarse irregular wrinkles near opening. Preanal scale evenly rounded at apex; margin at base subsinuate and not greatly thickened; surface sparsely punctate-striate.

Sterna twice as broad as long and crossed by about five transverse striae.

Gonopods as shown in Figs. 1 and 2.

Males with ventral crest of seventh segment thick, short and low.

Third male legs with coxal lobes directed caudally, the lobes vertical and decreasing on ensuing legs.

Watichelus edentatus, n. sp.

A single male type collected on the eastern side of the mountains beside the road from San

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[1] Received February 17, 1949.

Diego to El Centro, Calif., January 29, 1921, by O. F. Cook.

Diagnosis.—Distinguished by the more acute and bent lateral angles of the first segment and its shorter marginal groove, the lack of dentations on the hind margin of any of the segments, and by the male gonopods.

Description.—Length 38 mm; diameter 5 mm. Number of segments 46.

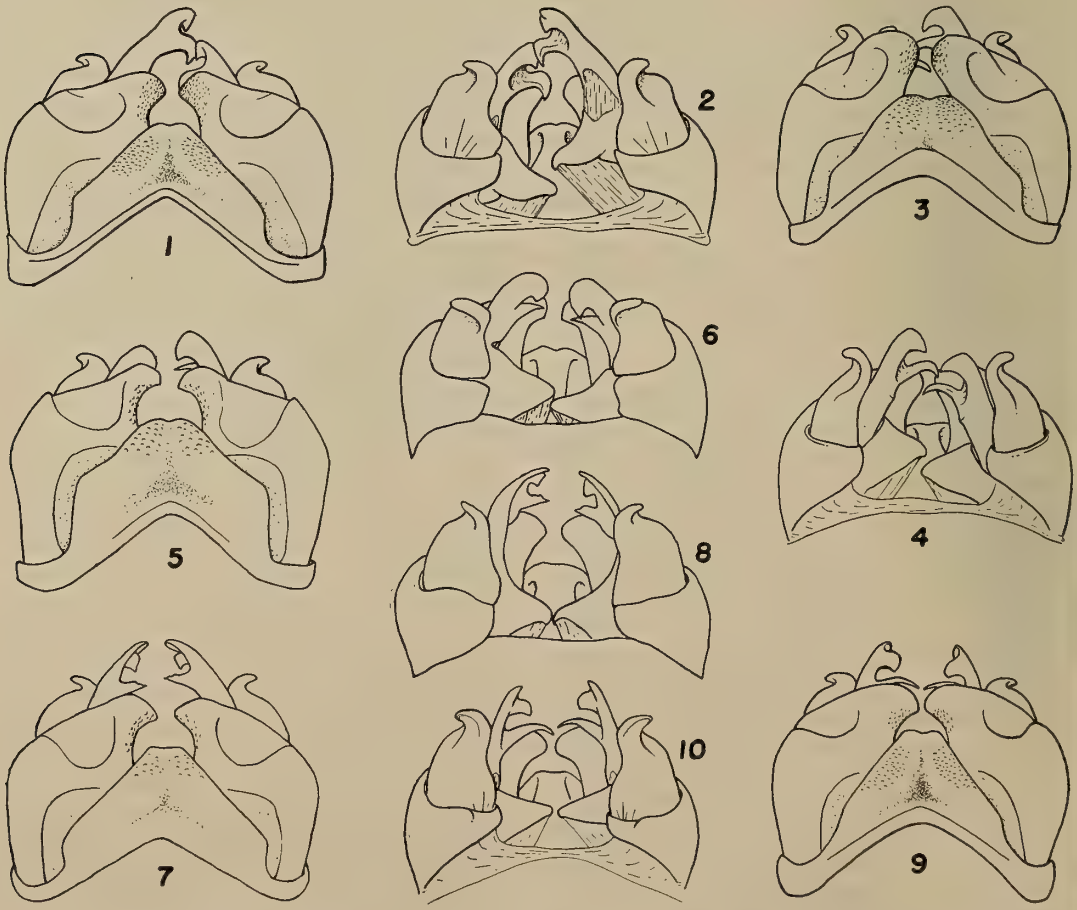
Head with a distinct median line on front and vertex but the two not joined; vertex finely rugulose; front with faint oblique transverse striations; clypeal punctures five on each side; eyes orbicular, composed of 25 or 26 inconspicuously raised ocelli in six longitudinal rows.

Segment 1 not wider than the following segments; the anterior median emargination broad and shallow, that above the acute lateral angle on each side long and distinct, the produced angle strongly bent backward and with the posterior margin above it more deeply emarginate than in the other species; marginal impressed line short, extending half the distance from the angle to the eye; surface very feebly and sparsely punctate, coarsely and irregularly striate.

Segment 2 with the anterior lateral margin not conspicuously raised.

Segment 3 with ventral crest abruptly raised, high, but short.

Following segments with the transverse constriction shallow, the surface behind it hardly convex; forebelt smooth and crossed by several long transverse striae; midbelt with numerous fine, short, irregular striae and a few feeble punc-



Figs. 1–10.—1, 2, Gonopods of *Watichelus robustus*, n. sp., anterior and posterior views respectively; 3, 4, gonopods of *Watichelus edentatus*, n. sp., anterior and posterior views, respectively; 5, 6, gonopods of *Watichelus cooki*, n. sp., anterior and posterior views, respectively; 7, 8, gonopods of *Watichelus emarginatus*, n. sp., anterior and posterior views, respectively; 9, 10, gonopods of *Watichelus parallelus*, n. sp., anterior and posterior views, respectively.

tations; hindbelt less striate but with distinct punctures widely placed; pore located well in advance of the constriction, in the midbelt, and followed by the impressed lateral sulcus on the hindbelt well above the line of the pores; ventral striations not as strong as in the other species and with the ridges between them not produced beyond the margin of the segment in sharp teeth.

Last segment broadly rounded, as long as the four preceding segments together; the penultimate segment is very short with the other three longer but subequal in length.

Anal valves scarcely exceeding the last segment, shining, the sides with widely scattered punctations and a few coarse wrinkles near the opening below the apex of the last segment.

Preanal scale nearly four times as wide as long, broadly rounded but subsinuate on each side; surface somewhat shining and with numerous impressed longitudinal aciculations.

Sterna of the legs two-thirds as long as broad.

Gonopods as shown in Figs. 3 and 4.

Male legs with coxal lobes small, those of the third legs largest, not caudally produced.

Ventral crest of seventh male segment rather thin and of moderate height and length, slightly excavated on either side in front to receive the tips of the gonopods.

Watichelus cooki, n. sp.

A male (type) and female collected at Descanso, Lower California, January 1, 1931, by O. F. Cook.

Diagnosis.—Near *edentatus*, but with several differences of the gonopods and with the posterior lateral margin of some of the segments toothed.

Description.—Length 38 to 40 mm; width 5 mm.

Head with 29 to 31 ocelli in a rounded cluster of six or seven rows, median sulcus of vertex faint, sulcus of front strong; front crossed by five or six oblique transverse wrinkles, clypeal fovea five each side.

First segment wider than succeeding segments, with lateral angles acute and bent backward, both margins above the apex emarginate, the anterior emargination deeper and more extensive and with a margining rim to behind eye, no median emargination; surface aciculate-punctate.

Second segment with ventral anterior margin rather thin but little elevated.

Crest of segment 3 short but raised into a sharply triangular lobe.

Segments with lateral sulcus strongly impressed on hindbelt, the median sulcus not or only very faintly impressed, transverse constriction slight; forebelt crossed by several faint striations; midbelt smooth, hindbelt very minutely punctate; lateral striations quite distinct, the adjacent margin with a few small teeth projecting beyond it; pore in midbelt, directly in front of the lateral sulcus.

Last segment as long as the three preceding segments together, broadly rounded and with a slight depression before the apex.

Anal valves quite strongly inflated, little flattened behind, meeting in a deep groove; surface more or less coarsely wrinkled.

Preanal scale three times as broad as long.

Sterna less than twice as broad as long crossed by five or six striations.

Gonopods as shown in Figs. 5 and 6.

Ventral crest of seventh segment short, thick, high and inclined sharply backward.

Coxal of male legs 3–6 little produced, those of legs 7 more so.

Watichelus smithi (Chamberlin)

Watichelus smithi (Chamberlin), Proc. Acad. Nat. Sci. Philadelphia **99**: 49–50. 1947.

This is the smallest and slenderest species of the genus and with only four clypeal fovea. The gonopods bear some resemblance to those of *cooki*, but differences are obvious.

Watichelus emarginatus, n. sp.

Three males (one the type) and a female from Lower California, "8 miles down" (below Tia Juana), January 1, 1925, O. F. Cook.

Diagnosis.—The less heavily constructed, more slender, inner gonopods, and the definitely emarginate penultimate segment distinguish this species.

Description.—Length 30 to 42 mm; width 4 to 5.5 mm. Number of segments 42–44.

Head with a distinct median sulcus on front and a faint one on vertex; surface with impressed, sometimes anastomosing, lines; clypeal fovea five on each side; ocelli about 32 in seven rows.

Segment 1 as wide as the next segments, with angles moderately produced and bent backward, a strong submarginal sulcus reaching to behind the eye; anterior and posterior emargination strong.

Segment 2 with anterior ventral margin thin and elevated.

Segment 3 with ventral crest rising abruptly into a triangular projection.

Segments with transverse constriction scarcely evident; forebelt transversely crossed by five or six almost continuous striae; midbelt faintly aciculated, otherwise smooth; hindbelt punctate and with minute longitudinal scratches; pore well in front of the hindbelt, followed by the impressed sulcus; median sulcus seldom evident; lateral striations well impressed, the upper posterior surfaces between them developed into minute marginal teeth, penultimate segment with a short but definite emargination of the back margin at middle.

Last segment as long as the three preceding segments, rather narrowly rounded behind, the apex usually preceded by a slight transverse depression.

Preanal scale broadly rounded, about three times as broad as long, surface smooth.

Anal valves moderately inflated, surface very coarsely wrinkled.

Sterna nearly twice as broad as long, crossed by six or seven striae.

Gonopods as shown in Figs. 7 and 8, with the inner gonopods more slender and less sturdy than in the other species.

Seventh segment of male with ventral crest moderately thick, long and high, inclined backward, and with the anterior face each side excavated to receive the tips of the gonopods.

In the males the coxal lobes of third legs are thicker but not as high as those of the legs that follow, where the lobes are subequal in size.

Watichelus parallelus, n. sp.

Collected at Chula Vista, Calif., January 23, 1921 (male and female), by O. F. Cook, and December 1921 (male type) by C. G. Marshall.

Diagnosis.—Distinguished by the strongly trifurcate inner gonopods, the pronounced denticulate segment margins, and the short angles of the first segment.

Description.—Length 36 to 40 mm; width 5.3 to 6 mm. Number of segments 40 to 42.

Head with the median grooves of the front and vertex distinct; vertex rugose along posterior portion; front with a strong transverse furrow either side of the median groove with other oblique and less distinct furrows above the transverse one; clypeus with five fovea each side; eye patch suborbicular, composed of about 30 ocelli in six rows.

Segment 1 as wide as the succeeding segments; lateral angle on each side shorter and not narrowed as much as in the other species although it still is curved backward somewhat.

Segment 2 with the anteroventral margin thin and greatly raised.

Segment 3 with ventral crest thin, rather short, and moderately raised.

Succeeding segments with the forebelt transversely striate; midbelt flat, not in the least convex, finely and thickly aciculated longitudinally; hindbelt punctate, inconspicuously striate, hardly more shining than midbelt; the transverse constriction distinct, the posterior subsegment evenly and rather strongly convex; pore located in front of the constriction; median and lateral grooves impressed on the hindbelt only, the latter behind or a little above the line of the pores and not showing the distinct offset apparent in *edentatus*; ventral striations pronounced, the upper corners of the areas between them produced beyond the hind margins of the segments into sharp, slightly upcurved teeth, especially conspicuous on the third quarter of the body.

The four segments preceding the last strongly telescoped and together about equalling it in length.

Last segment crossed behind middle by a broad variably evident impression; apex evenly rounded.

Anal valves vertical, moderately inflated and meeting in a shallow groove; surface with fine punctations and larger ones on the sides, and also with a number of coarse irregular striations.

Preanal scale longer than in other species, broadly rounded; surface shining and with a suggestion of punctures and short scratches.

Sterna of the legs two-thirds as long as broad, the sides nearly parallel.

Gonopods as shown in Figs. 9 and 10.

Segment 7 of male with ventral crest thick, high, and long.

Coxal lobes of third male legs vertical, thicker but not so high as those of fourth and fifth legs.

Another species that eventually may need to be placed in this genus is *Atopetholus paroicus* Chamberlin (Bull. Univ. Utah **31:** 7. 1941), based on females only, whose outstanding character was the first segment, which is typical of that in *Watichelus*. Males from the type locality will be needed to determine the correct generic assignment.

ORNITHOLOGY.—*A note on* Corythus splendens *Brehm.*[1] Alexander Wetmore, Smithsonian Institution.

Understanding of the geographic races to be recognized among the pine grosbeaks (*Pinicola enucleator*) of eastern North America has been subject to uncertainty, owing to the fact that most of the skins now in museums represent migrants, taken between fall and spring, with no indication as to their summer homes. The breeding range is mainly in distant, northern forests where it has been difficult to secure representative specimens. It has been hard, therefore, to judge to what degree the evident variation among them is individual or is representative of geographic segregation. Ludlow Griscom, in his excellent study of the pine grosbeaks of eastern North America,[2] has recognized two subspecies in this area, and has assigned to these the various scientific names that are applicable. The two forms that he recognizes, which are accepted by the A. O. U. Committee on Classification and Nomenclature, may be summarized as follows:

Pinicola enucleator leucura (Müller), marked by larger size, broader bill, and lighter coloration, particularly in the red of adult males: Breeds from Northwest Territories and northern Alberta to northern Quebec and Labrador, ranging south in winter to the northern United States from Nebraska to western Pennsylvania, more rarely to New England.

Pinicola enucleator eschatosus Oberholser, of smaller size, with narrower bill, in color slightly darker gray, with the red of the males more scarlet, less rosy: Breeds from Newfoundland south to Nova Scotia, northern Maine, and New Hampshire, south in winter to southern New England and New York, casually farther.

Several names that have been applied to these birds by the older authors are not determinable as to race from the data given in the original descriptions, so that Griscom has exercised the right of the first reviser to designate the form, of the two that he recognizes, to which they are to be applied. He has done this wisely, in a manner that has avoided useless changes in nomenclature. One of his allocations, however, that of *Corythus splendens* Brehm, has required consideration in connection with the current revision of the A. O. U. Check-list, since the specimen on which Brehm based his name is still extant, a fact of which Griscom in 1934 was unaware.

The type of *Corythus splendens* Brehm, an adult male in full plumage, formerly in the Brehm collection in Lord Rothschild's Museum, is now no. 457089 in the Bird Department of the American Museum of Natural History, where the authorities have kindly placed it in my hands for study. The bird was mounted, and has been remodeled as a study skin by straightening the neck and the legs, and by cutting off the wires that formerly held it to a perch. An original label, on narrow paper, is marked in written characters with carbon ink "*Corythus splendens* ♂ alt hieme Jan. 1833. Nordamerika." The bird is in excellent condition, with only slight fading from light exposure, and that confined mainly to the ends of the primaries and the tail. The crown and sides of the head are jasper red, the rump coral red, the breast and throat light coral red, and the reddish edgings on the back duller than jasper red.

Since Brehm's type, the reason for the present study, is a male, the following remarks are based entirely on an examination of male specimens. Examination of the series of pine grosbeaks in the National Museum substantiates Griscom's recognition of two groups on the basis of color, of which one, centering in Newfoundland and spreading to adjacent regions, is definitely darker. This dark bird also is small, as is shown by measurements of an excellent series of 17 males from Newfoundland, collected mainly by H. S. Peters and T. D. Burleigh: Wing 110.8–115.9 (113.5), tail 81.5–91.4 (85.8), culmen from base 13.6–15.9 (15.3), width of bill at base 9.0–9.9 (9.6), tarsus 21.2–23.1 (22.3) mm. The color differences are considered of major importance, as they are more distinctive, darker color being a general

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[1] Received February 8, 1949.

[2] Proc. New England Zoöl. Club **14**: 5–12. 1934.

characteristic of other races of birds recognized from the Newfoundland area. The size is variable and is, therefore, less certainly diagnostic. One bird from Ingonish, Nova Scotia, taken July 4, 1942, agrees fully with the Newfoundland series in darker color, and also is small in size. Its measurements are: Wing 109.0, tail 80.4, culmen from base 15.4, width of bill at base 9.6, tarsus 22.3 mm.

On analysis of the lighter colored specimens, in which the red of the males is more rosy, less scarlet, and the gray somewhat paler, one point develops that Griscom did not mention, namely, that these separate into two general groups on basis of size. In the larger set, measurements of 16 males are as follows: Wing 114.4–121.8 (117.1), tail 86.0–94.1 (89.8), culmen from base 15.0–16.4 (15.5), width of bill at base 10.0–11.0 (10.2) mm. Griscom has restricted the name *Loxia leucura* of P. L. S. Muller[3] to this larger group of individuals. In the series in the U. S. National Museum five males from Fort Chimo, northern Quebec, taken from April 13 to June 20, represent breeding birds of *leucura* on this basis.

A second series is smaller, measurements of ten winter males from Franklin County, Maine, Ossipee and South Sutton, N. H., Cambridge, Mass., Lake George, N. Y. (one), and the Emsdale District, Ontario (one), being as follows: Wing 108.0–115.4 (112.2), tail 80.6–87.8 (84.3), culmen from base 14.5–15.9 (15.2), width of bill at base 9.1–9.8 (9.5), tarsus 21.9–22.8 (22.2) mm. Possibly these represent intermediates between *eschatosus* and *leucura*, having the size of the former and the color of the latter.

The type of *Corythus splendens* Brehm is definitely light in color, like *leucura*, and has the following measurements: Wing 113.0, tail 89.7, culmen from base 15.7, width of bill at base 9.7, tarsus 21.8 mm. It thus agrees more closely in size with the smaller group. Should the smaller, lighter-colored individuals prove to have a broad enough breeding range to warrant their recognition as another eastern subspecies the name *splendens* may be available for them. In the meantime it can be stated definitely that this name does not affect the recognition of the breeding form of Newfoundland and Nova Scotia as *Pinicola enucleator eschatosus*, since Brehm's type, in lighter gray and brighter red, is like the large specimens of *leucura* where Griscom has allocated the name *splendens*. The darker color of the birds whose breeding area centers in Newfoundland is so pronounced both in shades of gray and of red that this character outweighs the slighter one of small size difference.

As stated above, Brehm's type, marked as taken in 1833, in North America, is of uncertain provenience, so that Griscom's restriction of the type locality to the city of Quebec can be accepted. The published basis for the name *Corythus splendens* is brief like many others of the earlier period, so brief in fact that without the type specimen proper identification would be impossible. Brehm[4] in some general remarks prefactory to an article on the birds of prey of Germany, mentions the Hakengimpeln, or pine grosbeaks, and says that "der amerikanische ist viel prächtiger, als der europaische, und soll desswegen *Corythus splendens* heissen." To say that a bird is brighter colored or prettier is far from a definite statement, but is in a sense descriptive. The only other use of the name *Corythus splendens* by Brehm is in some rambling natural-history observations made in America in 1845 and 1846[5] where he writes: "Vor etwa 6 vochen flog ein Vogel in das geoffnete Fenster der Frau Prof. N. Trügt mich nicht alles, ist es *Corythus enucleator* Cuv.*). Ich habe denselben erhalten; er schient mir aber kleiner zu sein als *Cor. enucleator*." And then below in a footnote is found "**Corythus splendens* Brm." From the text Brehm at the time was probably in Cambridge, Mass., though he does not say so definitely. In any event, the remarks have doubtful pertinence, since they do not refer to the type of 1833 but to another bird taken at the end of winter or in early spring of 1846, a specimen that so far as known is not extant. Actually, typical *Pinicola enucleator enucleator* of Europe is also a small race.

Burleigh and Peters[6] have identified their Newfoundland specimens properly as *escha-*

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[3] Natursyst. Suppl.: 150. 1776.

[4] Isis von Oken, 1840: 590.

[5] Allg. Deutsche Naturh. Zeit. **1** (6): 535. 1846.

[6] Proc. Biol. Soc. Washington **61**: 123. 1948.

tosus, which they collected also in summer on Petite Miquelon, and at Ingonish, Nova Scotia. Van Tyne[7] has recorded two size groups among pine grosbeaks from Michigan and Ohio, calling the smaller ones *eschatosus*. Sutton[8] reports two from Tompkins County, N. Y., on the same basis. In the light of the discussion above, and the present acceptance of two forms, it would seem necessary to re-examine the latter birds on the basis of color to determine where they are to be placed under the current recognition of only two forms in this area, viz. *leucura* and *eschatosus*.

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[7] Auk, 1934: 529–530.

[8] Auk, 1948: 125–126, pl. 5.

Obituaries

Dwight F. Windenburg was born in Lamont, Iowa, on May 14, 1895. After graduation from high school in 1912, he taught in the public schools of Iowa until he entered Cornell College, in Mount Vernon, Iowa, in 1916.

He left college during World War I to join the Navy, where he served afloat as a radio operator from December 1917 to March 1919. Following this duty he served as a radioman in the U. S. Merchant Marine for some 15 months.

Returning to Cornell College in Iowa, he graduated in 1921, and received his master's degree in physics from this college in 1923. He was a member of Phi Beta Kappa and Sigma Xi fraternities.

From 1923 to 1929 he taught mathematics in California, successively at the University of California, the Polytechnic College of Engineering at Oakland, and the Long Beach Junior College. At the last two institutions he served as head of the departments of mathematics.

In January 1929 he joined the staff of the U. S. Experimental Model Basin at Washington as a physicist, the first member of a group undertaking research and development in structural mechanics, of which he was later to become the head. He devoted the major part of his time to a project involving the strength of submarine hulls under external pressure, on which subject he became an authority in this country. Largely as a result of his efforts, there was developed the first external-pressure vessel code to be promulgated in the United States. As a leading member of the special research committee on the strength of vessels under external pressure of the American Society of Mechanical Engineers he participated in all the subsequent revisions of this code up to the time of his passing, which occurred on November 14, 1947.

When the new David Taylor Model Basin was commissioned in 1940, Dr. Windenburg, who has the year before obtained his Ph.D. degree from the Catholic University of America, was placed in charge of the structural mechanics division. Under his supervision and guidance, this division greatly expanded its activities until in the course of World War II it undertook important research and development for the Bureau of Ships in under-water explosion phenomena and action, the design and strength of turret structures, the invention and development of torpedo countermeasures, and many other allied projects. In recognition of this valuable work, he was awarded the Distinguished Civilian Service Award of the U. S. Navy Department.

As a part of his many activities he was a member of the Society for Experimental Stress Analysis, the Philosophical Society of Washington, the Washington Academy of Sciences, and the Instrument Society of America, of which he was vice-president of the Washington chapter. He served from time to time as a special lecturer in the graduate school of physics at the Catholic University.

Following World War II, Dr. Windenburg, who had throughout his governmental career taken a keen interest in the problems of the scientist working under Civil Service, was instrumental in bringing about many necessary changes in the methods of recruiting and examining applicants for these positions. Upon its establishment he was made a member of a pioneering group in the Potomac River Naval Command known as the Board of United States Civil Service Examiners for Scientific and Technical Personnel.

Harold E. Saunders.

William Ralph Maxon was born at Oneida, N. Y. , on February 27, 1877, the son of Samuel Albert and Sylvia Louisa (Stringer) Maxon. He entered Syracuse University in 1894 and received the degree Ph.B. in 1898. After graduating he accepted a temporary position at the New York Botanical Garden. On January 9, 1899, he was appointed aid in cryptogamic botany at the U. S. National Herbarium, Smithsonian Institution, and he remained with the Institution for nearly 50 years, retiring as curator of the National Herbarium in May, 1946. Syracuse University conferred the honorary degree Sc.D. in 1922. He died suddenly of a heart attack in Terra Ceia Fla., on February 25, 1948. He is survived by his wife, Edith Hinckley Merrill Maxon, and a daughter, Mrs. Mary Maxon Bergh.

Dr. Maxon was an internationally known student of ferns and the chief authority on the ferns of the United States. His interest in ferns began in college, where he prepared a thesis, never published, entitled *A contribution to the biology of the hart's-tongue fern.* His productivity in his earlier years was very great, and his published papers number 201, almost all on ferns. In later years Maxon's failing health made research work difficult, and he never lived to finish his larger projects, which he often worked on, but never got on paper. His major published work, other than his treatment of the ferns in Small's *Flora of the Southeastern States,* in Britton and Brown's *Illustrated Flora of the Northeastern United States and Canada,* and in Abram's *Illustrated Flora of the Pacific States,* is *Pteridophyta of Porto Rico,* the only modern, accurate treatment of the ferns of any part of tropical America. This work will remain indispensable for the study of West Indian ferns for many years.

Dr. Maxon's ability as an administrator was perhaps as important as his scientific contributions. His willingness to identify specimens brought in continual shipments of ferns from all over the world, which resulted in increasing the fern collection of the National Herbarium from negligible size to probably the largest in the world. Also by sponsorship of expeditions, by extensive exchanges, and by judicious purchases he brought the general collection of the National Herbarium up to one of the largest in the world. His own care in administrative detail doubtless had its influence on his colleagues in other institutions. Although professing boredom with administrative work, he really loved it, but, like many of us, he often wished that there were more hours in the day, so that he could devote time also to work on his *Ferns of Jamaica,* the research project in which he was most interested.

Maxon was a well-known and well-liked figure in botanical circles. He was a member of many scientific societies, and president of the American Fern Society for many years. Although in his later years he rarely traveled or attended scientific meetings, his official position and his extensive correspondence kept him in touch with fellow botanists. He had a genial and hearty nature and a delightful sense of humor. He will be long remembered by those who were fortunate to know him.

C. V. Morton.

GRANTS-IN-AID

The Washington Academy of Sciences has at its disposal $596.50, made available by the American Association for the Advancement of Science for the purpose of assisting young and promising scientists engaged on or planning worthy research projects. Grants may be used for the purchase of necessary equipment and supplies, or for compensation to an assistant, but may not be used to defray the costs of publication, or of typing the manuscript. The recipient of a grant is required to make progress reports on blank forms furnished by the A.A.A.S.

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Because most of the members of the Washington Academy of Sciences are associated with some governmental or private research agency and are provided with the necessary laboratory space, equipment, supplies, and other facilities required in their work, it is suggested that as far as possible the proposed projects not be related to the research being carried on as part of the applicant's regular duties.

J. Leon Shereshefsky, Chairman
Committee on Grants-in-Aid
Chemistry Department
Howard University
Washington 1, D. C.

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PHYSICAL CHEMISTRY.—*An excursion in chemical thermodynamics.*[1]

FREDERICK D. ROSSINI, National Bureau of Standards.

Thermodynamics provides laws that govern the passage of energy from one system to another, the transformation of energy from one form to another, and the utilization of energy for useful work. These same laws also govern the change of matter from one molecular or atomic species to another.

All matter of specified composition, in given electrical, magnetic, and gravitational fields, may be considered to have five fundamental thermodynamic properties—pressure, volume, temperature, energy, and entropy. Knowledge of the proper manner of applying the laws of thermodynamics to these fundamental properties of substances permits one to subject all transformations of energy and matter to the powerful scrutiny of thermodynamics.

Every physical process or chemical reaction, including biological ones, may be examined thermodynamically. However, the fruitfulness of such examination depends greatly upon the extent to which are known the fundamental properties of the initial and final states of the process or reaction. If the energy and entropy are known, with respect to appropriate reference points, for all values of pressure, volume, and temperature to be covered in the investigation, then the thermodynamic examination can be a complete one.

When under given conditions a chemical reaction takes place of its own accord, it is because the ensemble of atoms and molecules has an opportunity of improving its over-all situation with regard to energy and entropy. In the final state of a naturally occurring reaction or process, the atoms become arranged in molecular forms that have a more favorable combination of lower energy and higher entropy than in the initial state.

Given certain initial and final states of a proposed chemical reaction, it is frequently desirable to ascertain, without possible costly experimentation, what will be the amounts of the reacting material in the initial and final states, respectively, at thermodynamic equilibrium under the specified conditions. With known data on the changes in energy and entropy between the two states, under the given conditions of pressure, volume, and temperature, thermodynamics permits calculation of the amounts of material in the two states at equilibrium. If the amount of the material in the final state at equilibrium is very small, the proposed reaction has an unfavorable equilibrium under the specified conditions. If the amount of the material in the final state at equilibrium is large, the proposed reaction has a favorable equilibrium under the given conditions.

Another illustration of the power of chemical thermodynamics is the following: Given 10 possible products which may be formed from one starting substance, what are the amounts of the starting substance and of each of the 10 possible products at equilibrium under the specified conditions? With a knowledge of the difference in energy and in entropy between the starting substance and each of the 10 products, one can answer this question with confidence, without experimentation on the complex reaction involved.

In the foregoing examples it is important to note that thermodynamics does not evaluate the rate at which the given equi

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[1] Address of the retiring President of the Washington Academy of Sciences, delivered February 17, 1949. Received April 1, 1949.

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librium concentrations or amounts are reached, does not specify the mechanism by which the molecules are transformed from the initial to the final state and vice versa, and does not disclose any information regarding the details of the molecular structure of the molecules involved in the reaction.

The rate at which molecules pass from the initial state to the final state, and vice versa, in a given chemical reaction is determined by the energy of activation and the temperature. The rate of a specified reaction increases with increase in temperature and with decrease in the energy of activation. By means of a suitable catalyst, the energy of activation can be very materially reduced, producing a correspondingly large increase in the rate of reaction. The function of a catalyst is primarily twofold—to increase the rate of reaction and to guide the reaction along the desired course.

ENERGY AND THE FIRST LAW OF THERMODYNAMICS

There exists a property of every thermodynamic system called its energy, E, which is characterized by the fact that it is fully conserved over all systems in every process. The existence of energy is manifested to us through observations of the changes which it produces in material things. The various kinds of energy with which we are familiar include heat energy, mechanical kinetic energy, mechanical potential energy, electrical energy, and radiation energy.

Different processes have associated with them quite appreciably different amounts of energy. The following examples illustrate the tremendous variation in the magnitude of the changes in energy which accompany different processes:

Processes involving changes in the nuclei of atoms.—In the nuclear fission of uranium 235 with 1 neutron to form barium, krypton, and 3 neutrons,

$$U^{235} + n^1 = \mathrm{Ba} + \mathrm{Kr} + 3n^1, \qquad (1)$$

the energy given up by the system to the surroundings is approximately 4 × 10^{12} cal/mole.

Processes involving changes in the valence electrons of atoms or molecules.—In the recombination of an electron with a proton to form a neutral hydrogen atom,

$$\theta + \mathrm{H}^+ = \mathrm{H}, \qquad (2)$$

the energy given up by the system to the surroundings is about 3 × 10^5 cal/mole.

Processes involving changes in molecular structure.—In the reaction of hydrogen with oxygen to form water,

$$\mathrm{H_2} + \tfrac{1}{2}\,\mathrm{O_2} = \mathrm{H_2O} \qquad (3)$$

the energy given up by the system to the surroundings is about 6 × 10^4 cal/mole.

Processes involving changes of state, as from solid to liquid or liquid to gas.—In the condensation of water vapor to liquid water,

$$\mathrm{H_2O\ (gas)} = \mathrm{H_2O\ (liquid)}, \qquad (4)$$

the energy given up by the system to the surroundings is about 1 × 10^4 cal/mole.

Processes involving changes in translational, rotational, and vibrational energy in a molecule.—In the process of cooling gaseous oxygen from room temperature to near absolute zero,

$$\mathrm{O_2(gas,\ 300°K)} = \mathrm{O_2(gas,\ 0°K)}, \qquad (5)$$

the energy given up by the system to the surroundings is about 2 × 10^3 cal/mole.

Processes involving changes in mechanical potential energy.—When a mass of water is dropped from a height of 555 feet, the energy given up by the system to its surroundings is about 7 cal/mole.

Processes involving changes in mechanical kinetic energy.—In the stopping of a mass of water traveling with a speed of 50 miles per hour, the energy given up by the system to its surroundings is about 1 cal/mole.

In every process that occurs, every change in energy must be in accord with the first law of thermodynamics. This law governs not only the transfer of energy from one place to another, but also all the transformations of energy in its various forms.

The first law of thermodynamics was contained implicitly in the work of Carnot(*1*) in 1824 and of Mayer (*2*) in 1842, but was first stated unambiguously by Helmholtz(*3*) in 1847. The first law may be summed up in the statement that the energy of the universe remains constant. That is to say, whenever any process occurs, the sum of all the changes in energy, taken over all the systems participating in the process, is zero:

$$\Sigma \, \mathrm{d}E = 0. \tag{6}$$

In equation 6, E represents the energy of a given thermodynamic system, and the summation is to cover all systems.

In subjecting a given process to the scrutiny of the first law, it is usually convenient to specify or define a particular system which is inclosed by a surface through which passes, in or out, energy in its various forms, and to let all the other possible systems constitute one large surrounding system. Whenever any process occurs the net energy taken up by the given system will be exactly equal to the energy lost by the surroundings, and vice versa. The increase in the energy, E, of a given system participating in a process will be equal to the sum of all the different kinds of energy taken up by the system from the surroundings less the sum of all the different kinds of energy lost by the system to the surroundings. This may be expressed by the following relation, in which, for later convenience, three kinds of energy are distinguished:

$$\mathrm{d}E = \delta q + \delta w + \delta u. \tag{7}$$

In equation 7, $\mathrm{d}E$ is the differential increase in the energy of the system, and δq, δw, and δu are infinitesimal quantities of the various kinds of energy taken up by the system, with q representing heat energy, w representing "PV" work energy, and u representing all other forms of energy. In order to be added properly, the energies q, w, and u must be expressed in the same unit of energy, and must be labeled properly with respect to sign. Positive values of q, w, and u indicate that the given energy has been taken up by the system from the surroundings. Correspondingly, negative values of q, w, and u indicate that the given energy has been lost by the system to the surroundings.

Consider a process in which a given system passes from an initial state A to a final state B. During the process, the following amounts and kinds of energy pass into or from the system: a units of heat energy, b units of mechanical potential energy, c units of mechanical kinetic energy, d units of electrical energy, and f units of radiation energy pass from the surroundings into the system; g units of heat energy, h units of mechanical potential energy, i units of mechanical kinetic energy, j units of electrical energy, and k units of radiation energy pass from the system to the surroundings. The increase in the energy of the system as it passes from state A to state B is

$$E_{\mathrm{B}} - E_{\mathrm{A}} = \Delta E = a + b + c + d + f - g - h - i - j - k \tag{8}$$

or, in general, the increase in energy of the system is

$$\Delta E = q + w + u, \tag{9}$$

where q is the algebraic net amount of heat energy, w is the algebraic net amount of "PV" work energy, and u is the algebraic net amount of all other kinds of energy, passing into the system.

If the given process is performed in such a way that the pressure P of the system differs from the resisting pressure on expansion, or the impressed pressure on compression, only by a differential amount, then

$$\delta w = -P\mathrm{d}V. \tag{10}$$

For such a case, equation 7 becomes

$$\mathrm{d}E = \delta q - P\mathrm{d}V + \delta u \tag{11}$$

or

$$\mathrm{d}E + P\mathrm{d}V = \delta q + \delta u. \tag{12}$$

When the pressure is constant,

$$P\mathrm{d}V = d(PV), \tag{13}$$

and equation 12 becomes

$$\mathrm{d}(E + PV) = \delta q + \delta u. \tag{14}$$

Further, if for this special case there is no energy involved other than heat energy and "PV" work energy, then

$$\delta u = 0 \tag{15}$$

and equation 14 becomes

$$\mathrm{d}(E + PV) = \delta q, \tag{16}$$

which is applicable to a process occurring at constant pressure, with no energy other than heat energy and "PV" work energy. Because the combination of properties, $E + PV$, occurs frequently in thermodynamic problems, it is convenient to let

$$H = E + PV, \tag{17}$$

where H is named the heat content (or enthalpy). Equation 16 then becomes

$$\mathrm{d}H = \delta q, \tag{18}$$

which is the relation by which calorimetric measurements of the heat energy associated with a specified reaction or process may be used to evaluate the change in heat content, ΔH, for the given reaction or process.

It is important to note that the first law of thermodynamics is concerned only with changes in the energy of material systems and not with the absolute value of the energy of any system. However, in making thermodynamic calculations of energy, particularly of the energy of chemical reactions, it is convenient to select certain reference states of the substances to which are arbitrarily assigned values of zero energy. Such reference states may be, for example, the chemical elements in the physical state in which they occur naturally at 25°C., or they may be the chemical atoms in the gaseous monatomic state at the absolute zero of temperature, or they may be, also at the absolute zero of temperature, the neutrons, protons, and electrons from which atoms may be formed.

ENTROPY AND THE SECOND LAW OF THERMODYNAMICS

Every system, if left to itself, changes rapidly or slowly in such a way as to approach a definite final state of rest or equilibrium(*4,5*). Examples of processes tending toward such equilibrium are the following: The diffusion of solute material from a concentrated solution into a dilute solution, leading to uniform concentration; the passage of heat from a hot body to a cold body, leading to uniformity of temperature; the combustion of coal in air; the running down of a mechanical clock.

As these processes tend toward their final state of rest or equilibrium, the systems lose some measure of their capacity for spontaneous change. If we wish to harness one of these spontaneously occurring processes to do useful work, we would select one removed as far as possible from its state of rest or equilibrium, and which has a sufficiently high rate of change toward that equilibrium.

The passage of a system toward equilibrium does not necessarily mean that its energy is decreasing. That energy may be constant. What is being lost is the capacity of the system for spontaneous change.

This brings us to the idea that there exists a property of every thermodynamic system, called its entropy, S, which is associated with its capacity for spontaneous change. The property is characterized by the fact that it is fully conserved over all systems for every reversible process, in which every driving force or pressure differs from the resisting force or pressure only by a differential amount, but increases for all other processes.

Whenever any process occurs, under any conditions, the sum of all the changes in entropy, taken over all the systems involved, is equal to or greater than zero:

$$\Sigma\, \mathrm{d}S \geqq 0. \tag{19}$$

When the given process is a reversible one, the sum of all the changes in entropy, taken over all the systems participating in the reversible process, is equal to zero:

$$\Sigma\, \mathrm{d}S = 0. \tag{20}$$

In subjecting a given process to the scrutiny of the second law of thermodynamics it is usually convenient to specify or define a particular system, and to let all other possible systems constitute one large surrounding system. Whenever any reversible process occurs, the increase in the entropy of the given system is equal to the decrease in the entropy of the surroundings, and vice versa.

The change in entropy of a given system participating in a reversible process is quantitatively defined as

$$\mathrm{d}S = \delta q/T. \tag{21}$$

In equation 21, $\mathrm{d}S$ is the differential increase in entropy of the given system and δq is an infinitesimal quantity of heat energy absorbed by the given system at the absolute temperature T. Equation 21 may also be written as

$$\delta q = T\mathrm{d}S. \qquad (22)$$

When any system passes from an initial state A to a final state B in any given process, the value of the change in entropy is independent of the path or manner of the change, being fixed entirely by the properties of the states A and B. For example, consider the expansion at constant temperature of one mole of an ideal gas from an initial pressure, P_A, and volume, V_A, to a final pressure, P_B, and volume, V_B. The change in entropy for this process is, irrespective of the path,

$$\Delta S = S_B - S_A. \qquad (23)$$

If the expansion occurs freely, with no resisting pressure, no useful work will be produced in the expansion. If the expansion occurs reversibly, with the resisting pressure being always less than the pressure of the gas, P, by an amount $\mathrm{d}P$, a maximum amount of useful work will have been obtained. In either case, the value of the change in entropy is the same.

In general, the change in entropy for any process having known initial and final states can be evaluated as the negative of the process of restoring the system reversibly to its initial state from the final state. In the above example of the isothermal expansion of an ideal gas, the value of $S_B - S_A$, in whatever manner the expansion occurred, could be evaluated as the negative of the change in entropy associated with the isothermal and reversible compression of the ideal gas from state B to state A. The evaluation would involve measurement of the heat given up by the system (one mole of ideal gas) to the surroundings during the isothermal and reversible compression.

EQUILIBRIUM AND FREE ENERGY

Criterion of equilibrium.—For a reversible process, the first law gives the relation (equation 11)

$$\mathrm{d}E = \delta q - P\mathrm{d}V + \delta u, \qquad (24)$$

and the second law gives the relation (equation 22)

$$\delta q = T\mathrm{d}S. \qquad (25)$$

Combination of these equations, with rearrangement of the terms, yields the following important relation applicable to a process performed reversibly:

$$-\delta u = -(\mathrm{d}E + P\mathrm{d}V - T\mathrm{d}S). \qquad (26)$$

This interesting relation tells us that for any process performed reversibly the useful energy obtainable from the system is completely expressible in terms of the five fundamental thermodynamic properties P, V, T, E, and S. That is to say, $-\delta u$ is the useful energy available or the energy which is free to be put to some useful purpose. Whenever $-\delta u$ has a positive value, that is, when the given process gives up some useful energy, it is associated with the spontaneous passage of the system toward its state of rest or equilibrium.

When $-\delta u$ has a negative value (or δu has a positive value), some useful energy must be supplied by the surroundings to the system in order to carry on the specified process. In the latter case, the process is one which cannot proceed spontaneously. In this case, therefore, the given change must be in a direction away from equilibrium, since movements toward equilibrium are ones which occur of their own accord, and those away from equilibrium are ones which do not occur of their own accord.

In the case where

$$\delta u = 0, \qquad (27)$$

no useful energy passes from or into the system in the given process, and it follows that the system is moving neither toward equilibrium (yielding energy, with $-\delta u$ positive) nor away from equilibrium (requiring energy to be supplied, with $-\delta u$ negative). Hence, the system must already be at the state of equilibrium.

Therefore, equation 27, or its equivalent,

$$\delta u = \mathrm{d}E + P\mathrm{d}V - T\mathrm{d}S = 0 \qquad (28)$$

may be used as the general criterion of equilibrium.

Free energy.—Many processes take place at constant pressure and temperature. Under such circumstances,

$$P\mathrm{d}V = \mathrm{d}(PV) \qquad (29)$$

and

$$TdS = d(TS). \tag{30}$$

Combination of equations 28, 29, and 30 yields for the criterion for equilibrium at constant pressure and temperature,

$$d(E + PV - TS) = 0. \tag{31}$$

The combination of properties, $E + PV - TS$, occurs frequently in chemical thermodynamic problems, and it is convenient to let

$$F = E + PV - TS, \tag{32}$$

where F is named the free energy. (At constant pressure and temperature, the decrement in the value of F is the energy which is free to be put to useful purposes.) With this notation, equation 31 becomes

$$dF = 0. \tag{33}$$

That is, at constant pressure and temperature, the criterion for equilibrium is that the change in free energy is zero.

It should be noted that the definitions of the two functions H (equation 17) and F (equation 32) are such as to produce the relation

$$F = H - TS. \tag{34}$$

Free energy of an ideal gas.—When a given system participates in a reversible process in which only heat energy and "PV" work energy occur, then

$$\delta u = 0 \tag{35}$$

and

$$dE + PdV - TdS = 0. \tag{36}$$

Differentiation of the equation defining F yields

$$dF = dE + PdV + VdP - TdS - SdT. \tag{37}$$

Combination of equations 36 and 37 yields

$$dF = VdP - SdT. \tag{38}$$

At constant temperature, equation 38 reduces to

$$dF = VdP, \tag{39}$$

which gives the change of free energy with pressure at constant temperature. Similarly, at constant pressure, equation 38 reduces to

$$dF = -SdT, \tag{40}$$

which gives the change of free energy with temperature at constant pressure.

If the given substance subjected to the foregoing process is an ideal gas, then

$$V = RT/P \tag{41}$$

and equation 39 becomes

$$dF = VdP = (RT/P)dP = RTd\ln P. \tag{42}$$

Equation 42 gives the change of free energy of an ideal gas with pressure at constant temperature.

Equilibrium constant for reactions involving ideal gases.—Let us consider a simple chemical reaction occurring in the ideal gaseous state at a given temperature:

$$\mathrm{mM(gas)} = \mathrm{nN(gas)}. \tag{43}$$

Here, M and N denote the reactant and the product substances respectively and m and n are small integers giving the stoichiometric relation between the number of moles of the two kinds of substances participating in the reaction.

For the substances M and N in certain states s, we may write the change in free energy for this reaction as

$$\Delta F_s = \mathrm{n}(F_{\mathrm{N}})_s - \mathrm{m}(F_{\mathrm{M}})_s. \tag{44}$$

Similarly for the substances M and N in certain states e, we may write the change in free energy as

$$\Delta F_e = \mathrm{n}(F_{\mathrm{N}})_e - \mathrm{m}(F_{\mathrm{M}})_e. \tag{45}$$

Subtraction of equation 45 from equation 44 gives

$$\Delta F_s - \Delta F_e = \mathrm{n}(F_s - F_e)_{\mathrm{N}} - \mathrm{m}(F_s - F_e)_{\mathrm{M}} \tag{46}$$

which is the difference in the change of free energy for the two sets of conditions.

Integration of equation 42 between the pressure corresponding to the states s and e, respectively, yields, for the difference in free energy of one mole of the ideal gas M between the states s and e

$$(F_s - F_e)_{\mathrm{M}} = RT\ln(P_s/P_e)_{\mathrm{M}}. \qquad (47)$$

and similarly for the ideal gas N,

$$(F_s - F_e)_{\mathrm{N}} = RT\ln(P_s/P_e)_{\mathrm{N}}. \qquad (48)$$

Combination of equations 46, 47, and 48 yields

$$\Delta F_s - \Delta F_e = \mathrm{n}RT\ln(P_s/P_e)_{\mathrm{N}} - \mathrm{m}RT\ln(P_s/\mathrm{P}_e)_{\mathrm{M}}. \qquad (49)$$

Rearrangement of equation 49 gives

$$\Delta F_s - \Delta F_e = RT\ln(P_{\mathrm{N}}{}^{\mathrm{n}}/P_{\mathrm{M}}{}^{\mathrm{m}})_s - RT\ln(P_{\mathrm{N}}{}^{\mathrm{n}}/P_{\mathrm{M}}{}^{\mathrm{m}})_e. \qquad (50)$$

Letting

$$Q = P_{\mathrm{N}}^{\mathrm{n}}/P_{\mathrm{M}}^{\mathrm{m}} \qquad (51)$$

be the "proper quotient of pressures" for the reaction given in equation 43, we may write equation 50 as

$$\Delta F_s - \Delta F_e = RT\ln Q_s - RT\ln Q_e. \qquad (52)$$

Let the states *s* be identified as standard states, with

$$P_{\mathrm{M}} = P_{\mathrm{N}} = 1. \qquad (53)$$

Then

$$Q_s = 1 \text{ and } RT\ln Q_s = 0. \qquad (54)$$

Following the nomenclature of Lewis and Randall (*4*) for designating standard states, we write

$$\Delta F_s = \Delta F^\circ. \qquad (55)$$

Let the states *e* be identified as equilibrium states. Then for these states the "proper quotient of pressures" is defined as the equilibrium constant, *K*,

$$Q_e = K, \qquad (56)$$

and, from equation 33, the change in free energy at equilibrium at constant temperature and pressure is zero, so that

$$\Delta F_e = 0. \qquad (57)$$

On appropriate substitution into equation 52, one obtains the familiar relation between the equilibrium constant and the standard change in free energy:

$$\Delta F^\circ = -RT\ln K. \qquad (58)$$

From equation 34, we may write for any reaction

$$\Delta F = \Delta(H - TS) = \Delta H - \Delta(TS). \qquad (59)$$

At constant temperature, this equation becomes

$$\Delta F = \Delta H - T\Delta S. \qquad (60)$$

If each reactant and product is in its thermodynamic standard state, then, further,

$$\Delta F^\circ = \Delta H^\circ - T\Delta S^\circ = -RT\ln K. \qquad (61)$$

From this equation, we may write the equilibrium constant explicitly as

$$K = (\mathrm{e}^{\Delta S^\circ/R})\,(\mathrm{e}^{-\Delta H^\circ/RT}). \qquad (62)$$

For any reaction, equation 62 shows that the atoms constituting the molecules involved in the reaction will tend to go preferentially into those molecular configurations in which the entropy is greatest and in which the energy is lowest (algebraically). The greatest entropy is in general associated with those molecular configurations having the largest number of states of existence, that is, those molecular configurations in which the atoms will have the greatest freedom of existence. On the other hand, the lowest energy is in general associated with those molecular configurations in which the atoms are bound most strongly, one to another, that is those molecular configurations in which the atoms will have the greatest structural security. The final state of equilibrium is a compromise between these two opposing tendencies, toward maximum freedom on the one hand and maximum security on the other.

Further examination of equation 62 shows that for those reactions in which the values of ΔS° and ΔH° do not change too greatly with temperature, the equilibrium at low temperatures is determined largely by the value of ΔH°, the "security" term, whereas at high temperatures the equilibrium is determined largely by the value of ΔS°, the "freedom" term.

In considering the possible production of a needed material of commerce by means of a number of proposed chemical reactions, one of the practical things to be known first about each reaction is the value of the equilibrium constant as a function of temperature. For many reactions it is not possible to determine the equilibrium constant directly, except at a prohibitive cost, and it becomes necessary to evaluate the equilibrium constant by means of the standard change in entropy, $\Delta S°$, and the standard change in heat content, $\Delta H°$, for each reaction.

The values of the standard change in entropy, $\Delta S°$, for a given reaction may be obtained from the values of the entropies of each of the reactants and each of the products. The values of the entropies of the individual compounds may be determined by application of the third law of thermodynamics to measurements of heats of transition, fusion, and vaporization, and heat capacities, down to low temperatures or by statistical calculations utilizing spectroscopic and other molecular data.

The values of the standard change in heat content, $\Delta H°$, may be obtained from calorimetric measurements of the heats of appropriately selected chemical reactions.

From the values of the equilibrium constant as a function of temperature, the optimum temperature of operation for maximum yield is selected. The next point to be investigated is whether, at the selected temperature, the given reaction can be made to proceed at a sufficiently rapid rate for practical operation. Since the rate of reaction increases markedly with temperatures, those reactions to be operated at high temperatures will usually offer little difficulty regarding the rate of reaction, although considerable trouble from the occurrence of undesired side reactions may occur. However, if the reaction is to be run at a low temperature, it will usually be necessary to find for the given reaction a specific catalyst which will produce a sufficiently rapid rate without introducing a significant amount of undesired side reaction.

EVALUATION OF HEATS OF REACTION

The ideal thermochemical table is one which will permit the calculation of the heat of every chemical reaction. Obviously it would be impractical to list in a table the heat of every reaction, but the same end is accomplished by listing for each chemical substance its heat of formation from the elements in selected standard states. It is evident that, by proper selection, the number of chemical reactions whose heats must be measured will be about the same as the number of substances listed in the table. Some saving in the number of reactions to be measured will occur among the organic compounds because of certain correlations which permit the evaluation of the heat of formation of higher members of homologous series, similar isomeric structures, etc.

The value of the heat of formation of a given substance may be the result of the determination of the heat of one reaction, as in the formation of liquid water from gaseous oxygen and hydrogen. For many other substances, however, the value will result from the measurement of the heats of several reactions. For example, the value of the heat of formation of methane, from its elements carbon and hydrogen, depends upon measurements of the heats of the following three reactions: the heat of combustion of gaseous methane in gaseous oxygen to form liquid water and gaseous carbon dioxide; the heat of combustion of solid carbon in gaseous oxygen to form gaseous carbon dioxide; and the heat of combustion of gaseous hydrogen in gaseous oxygen to form liquid water.

There will be certain basic values in the table which will be used very frequently in the derivation of other values. These basic values, which should be known with considerable accuracy, include the heats of formation of water, carbon dioxide, nitric acid, sulfuric acid, hydrogen chloride, hydrogen sulfide, and others. Because of this interdependence of many of the values of heats of formation, it is extremely desirable that values for the important thermochemical constants be carefully selected, and when any change is made in any one of the basic values, corresponding changes should be made in all the values which depend upon it. It is for this same reason that the addition or substraction of values of heats of formation from different thermochemical tables is a precarious undertaking.

In order to determine the value of the heat of formation of a substance, one selects for measurement reactions in which all the reactants and products, except the given substance, are either elements in their standard reference states or are substances whose heats of formation are known.

The chemical reactions whose heats are to be measured must be ones which proceed to completion (except in so far as a small amount of side reaction is known and can be corrected for) and for which the amount of reaction can be accurately measured.

The principle of the modern experimental method in thermochemistry is to carry out the reaction to be studied in the calorimeter in such a manner that it will be possible to compare the heat evolved by the chemical reaction with the heat evolved by electrical energy or with the heat evolved by a measured amount of a standard chemical reaction, the heat of which has already been compared with electrical energy.

EVALUATION OF ENTROPIES

Entropies from the third law of thermodynamics.—In evaluating entropies by means of the third law of thermodynamics, use is made of the relation (equation 21) given by the second law, namely,

$$dS = \delta q/T. \qquad (63)$$

On integration of this relation, we obtain

$$S - S_0 = \textstyle\int_0^T \delta q/T, \qquad (64)$$

where S_0 is the entropy of the given system (substance) at the absolute zero of temperature. Actually, of course, measurements can not be carried to the absolute zero of temperature. The investigator makes measurements down to the lowest temperature, T_*, attainable in the given investigation, at which temperature the substance should be in the condensed state, and the values of the integral below T_*, are obtained by extrapolation. Indicating this fact, we may write

$$S - S_0 = \left(\int_0^{T_*} \delta q/T\right)_{\text{extrap.}} + \int_{T_*}^{T} \delta q/T. \qquad (65)$$

The last term on the right side of equation 65 is evaluated completely from the experimental observations of heat capacity, and heats of transition, fusion, and vaporization. The first term on the right side of equation 65 is obtained by extrapolating from T_* to the absolute zero of temperature the measurements of heat capacity made above T_*, in conjunction with an appropriate theoretical equation, usually the Debye (*6*) equation for the heat capacity of solids. The extrapolation from T_* to 0°K in this way accounts for the ordinary thermal entropy resident in the substance at T_*, the lowest temperature of measurement. The term S_0 represents, therefore, the entropy of the substance at the absolute zero of temperature as determined essentially by its quantum condition at T_*.

A simple statement of the third law is the following: "If at the lowest temperature of measurement, T_*, the substance is in a single pure quantum state of energy, except for the ordinary thermal energy characteristic of T_* that is accounted for by the extrapolation from T_* to 0°K, then S_0 may be placed equal to zero." When this condition holds, then equation 65 becomes

$$S = \left(\int_0^{T_*} \delta q/T\right)_{\text{extrap.}} + \int_{T_*}^{T} \delta q/T. \qquad (66)$$

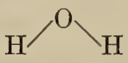
In such cases, the entropy at the temperature T is determined almost completely from the calorimetric observations. (It is obvious that T_* should be made as low as possible in order that the extrapolation shall introduce as small an uncertainty as possible.)

From the data which are now available, it is known that many molecules, including all of the large number of hydrocarbons so far measured, conform to the requirements of the third law as stated above. On the other hand, the following substances have been measured calorimetrically down to the temperature of liquid hydrogen and have, for the reasons indicated, been found to possess at the lowest temperature of measurement, T_*, entropy in excess of that associated with the ordinary thermal energy characteristic of the crystal at T_*: ordinary hydrogen, H_2, and "heavy" hydrogen, H_2^2 or D_2, entropy associated with a nonequilibrium distribution of the molecules among the odd and the even levels of energy (so-called mixture of ortho and para hydrogen) (*7*); ordinary water, H_2O, and "heavy" water, H_2^2O or D_2O, entropy associated with the randomness of arrangement of the hydrogen bonds in the crystal (*8*); carbon monoxide, CO, nitric oxide, NO, and nitrous oxide, NNO, entropy associated with a random or partially random "end-for-end" arrangement of the molecules in the crystal (*9, 10, 11, 12*).

[For detailed discussion regarding entropy and the third law of thermodynamics, the reader is referred to Lewis and Randall (*4*), Eastman (*13*), and Pauling and Eastman (*14*).]

Entropies from statistical calculations.—Theoretical and experimental investigations in physics and chemistry have yielded a relatively simple picture of molecular structure which is in substantial accord with all known facts and accepted theories.

For example, consider the water molecule, H_2O, in the gaseous state, at a pressure sufficiently low that interactions between the molecules are negligible. The picture is one of a symmetrical triangular-shaped molecule



with the oxygen atom between, and bonded to, the two hydrogen atoms. The angle formed by the three atoms is 104°27′, and the centers of the hydrogen atoms are 0.9584×10^{-8} cm from the center of the oxygen atom (*15*).

The molecule has a total of nine degrees of ordinary freedom (three times the total number of atoms in the molecule), of which three are translational, three are rotational, and three are vibrational. For simplicity, we may consider that there is a complete set of discrete levels of energy associated with each degree of freedom. (Actually, the situation is considerably simplified for translation because the three degrees of translational freedom are identical and fully "excited" (see later discussion) to their classical values, and is more complicated for rotation and vibration because of interactions between them.) According to the simple picture, a single gaseous water molecule will have at a given instant an amount of energy which is the sum of nine discrete quantities, one from each of the nine sets of levels of energy. Each set of levels of energy may be represented as follows:

Energy levels	Number of the given level	Energy of the given level	Number of states at the given level
——	i	ϵ_i	g_i
⋮	⋮	⋮	⋮
——	3	ϵ_3	g_3
——	2	ϵ_2	g_2
——	1	ϵ_1	g_1
——	0	ϵ_0	g_0

The levels of energy are numbered as indicated, beginning with zero at the bottom, lowest, or ground level. The energy of each level is represented by $\epsilon_0, \epsilon_1, \epsilon_2, \epsilon_3, \cdots \epsilon_i$. The multiplicity, or number of individual states existing at each level of energy, is given by $g_0, g_1, g_2, g_3, \cdots g_i$. The distribution of molecules among the possible levels of energy is given by the Boltzmann distribution law:

$$n_i = n_0 \, e^{-(\epsilon_i - \epsilon_0)/kT}. \qquad (67)$$

This equation gives the population of each state at each level of energy, as a function of the temperature, in terms of the number of molecules in one state at the ground level. The calculation requires only the specification of the temperature and a knowledge of the difference in energy between each possible level and the ground level. Simple application of equation 67 indicates that at the absolute zero of temperatue all the molecules would be on the ground state and that at a temperature which is extremely large (in comparison to the value of $(\epsilon_i - \epsilon_0)/k$) the molecules would be distributed substantially uniformly in number over all the possible states of energy. This latter statement corresponds to having that particular degree of freedom fully "excited" to its classical value. This is so in the case of the three translational degrees of freedom even down to temperatures very near the absolute zero.

At sufficiently high temperatures, we need to consider, in addition to translation, rotation, and vibration, also a new degree of freedom arising from excitation of the valence electrons in the molecule, which gives rise to a set of levels of electronic energy.

The order of magnitude of the spacing of the levels of energy near the ground level in the various sets of energy levels is as follows, in cal/mole: translational, 10^{-21}; rotational, 10 to 10^2; vibrational, 10^3 to 10^4; electronic, 10^4 to 10^5. We can calculate from equation 67 that for one mole of molecules at room temperature the population of molecules in the first state of electronic energy will usually be entirely negligible, and that the population in the first vibrational state will be very small; whereas, the rotational degrees of freedom will usually be nearly fully "excited" and the translational degrees of freedom will always be fully "excited".

For our calculation, we may take the total number of molecules as one mole, N, approximately 6×10^{23}. Then

$$N = \Sigma n_i g_i = \Sigma n_0 g_i \mathrm{e}^{-(\epsilon_i - \epsilon_0)/kT} \quad (68)$$

or, since n_0 is constant at a given temperature,

$$n_0 = N/\Sigma g_i \mathrm{e}^{-(\epsilon_i - \epsilon_0)/kT} \quad (69)$$

Combination of equations 67 and 68 gives

$$n_i = N(\mathrm{e}^{-(\epsilon_i - \epsilon_0)/kT})/\Sigma g_i \mathrm{e}^{-(\epsilon_i - \epsilon_0)/kT}. \quad (70)$$

The total energy of the one mole of molecules, referred to the ground level, is for the given set of energy levels,

$$E\text{-}E_0 = \Sigma n_i g_i(\epsilon_i - \epsilon_0) = N\Sigma g_i(\epsilon_i - \epsilon_0)\,(\mathrm{e}^{-(\epsilon_1 - \epsilon_0)/kT})/\Sigma g_i \mathrm{e}^{-(\epsilon_i - \epsilon_0)/kT}. \quad (71)$$

For convenience, we take the following abbreviations (*16*):

$$A_i = g_i^{-(\epsilon_i - \epsilon_0)/kT} \quad (72)$$

$$B_i = (\epsilon_i - \epsilon_0)A_i \quad (73)$$

$$D_i = (\epsilon_i - \epsilon_0)B_i. \quad (74)$$

It may be noted that

$$\mathrm{d}A_i/\mathrm{d}T = B_i/kT^2 \quad (75)$$

and

$$\mathrm{d}B_i/\mathrm{d}T = D_i/kT^2. \quad (76)$$

With these abbreviations, the energy of one mole of molecules at the temperature T, as given by equation 71, is, for the energy from each set of energy levels,

$$E - E_0 = N\Sigma B_i/\Sigma A_i. \quad (77)$$

Once the energy of one mole of molecules is known as a function of the temperature, then the other thermodynamic functions may be evaluated from the ordinary thermodynamic relations. For one mole of molecules in the ideal gaseous standard state (indicated by the superscript °), the following relations hold:

$$PV = RT \quad (78)$$

$$H^\circ = E^\circ + (PV)^\circ = E^\circ + RT. \quad (79)$$

At the absolute zero of temperature (indicated by the subscript $_0$), $T = 0$ and

$$H^\circ_0 = E^\circ_0. \quad (80)$$

Then combination of equations 79 and 80 yields the value of the heat content function,

$$(H^\circ - H^\circ_0)/T = (E^\circ - E^\circ_0)/T + R. \quad (81)$$

The heat capacity is given by the relations

$$C^\circ_V = (\delta E^\circ/\delta T)_V \quad (82)$$

or

$$C^\circ_V = (N/kT^2)\,[(\Sigma D_i/\Sigma A_i) - (\Sigma B_i/\Sigma A_i)^2]. \quad (83)$$

The entropy is given by the relation

$$S^\circ = \int C^\circ_V \,\mathrm{d}\ln T = \int (\partial E^\circ/\partial T)\,\mathrm{d}\ln T \quad (84)$$

or, for each of the sets of energy levels,

$$S^\circ = R\ln \Sigma A_i + (N/T)\,(\Sigma B_i/\Sigma A_i). \quad (85)$$

The free energy function is given by the relation

$$(F^\circ - H^\circ_0)/T = (H^\circ - H^\circ_0)/T - S^\circ \quad (86)$$

or, the contribution from all the sets of energy levels, is

$$(F^\circ - H^\circ_0)/T = R(1 - \ln\Sigma A_i) \quad (87)$$

where Σ indicates that the summation is to be taken over all the different sets of energy levels. It may be noted that, of the above functions, the free energy function is the most easily calculated since it involves only the terms of ΣA_i. As will be seen later, the free energy function is also one of the most useful for calculations of thermodynamic equilibria.

From the foregoing, it is seen that when the complete diagram of the sets of energy levels is known for a given molecule in the ideal gaseous state, the values of the thermodynamic functions may be calculated accurately in a straightforward manner. The status of the calculation of the contributions to the values of the thermodynamic functions from the several degrees of freedom for a molecule in the ideal gaseous state is as follows (*17*, *18*):

The calculation of the translational contribution may be made accurately for all temperatures for all molecules from the molecular weight, the temperature, and known constants.

The calculation of the rotational contributions may be made quite accurately for all temperatures for the relatively few simple molecules for which a complete diagram of the sets of rotational energy levels is known, and with reasonable accuracy for ordinary and moderate temperatures for those molecules for which the moments of inertia are known (or calculable from the bond angles and distances).

The calculation of the vibrational contributions may be made quite accurately for all temperatures for the relatively few simple molecules for which a complete diagram of the sets of vibrational energy levels is known, and with reasonable accuracy for ordinary and moderate temperatures for those molecules for which the first level is known for each set of levels of vibrational energy. (These are calculable from the fundamental frequencies of vibration.)

The calculation of the electronic contribution, which becomes significant only at relatively high temperatures, can be made only when the appropriate levels of electronic energy are known.

In the case of hydrocarbon and other molecules having groups of atoms which can oscillate with rather large amplitude, or even rotate completely, about a given bond, the determination of the proper set of energy levels to be associated with such a degree of freedom is complicated. When the restriction to rotation is extremely large, the energy levels approach those of a simple harmonic oscillator (for which only the frequency of vibration need be known), while, when the restriction to rotation is extremely small, the energy levels may be taken to be those of a simple rotator (for which only the moment of inertia need be known).

[The reader is referred to Tolman (*17*) and Mayer and Mayer (*18*) for detailed discussions regarding the statistical calculation of thermodynamic functions, and to Pitzer (*19*), Pitzer and Gwinn (*20*), Crawford (*21*), and Wilson (*22*) for detailed discussion of restricted internal rotation as involved in the calculation of thermodynamic functions.]

EVALUATION OF CHEMICAL EQUILIBRIUM CONSTANTS

The increment of the free energy function, $\Delta(F^\circ - H^\circ_0)/T$, for a given reaction is the sum of the values of the free energy function for the products of the reaction less the sum of the values of the free energy function for the reactants:

$$\Delta(F^\circ - H^\circ_0)/T = \Sigma\,(\text{products})\,(F^\circ - H^\circ_0)/T - \Sigma\,(\text{reactants})\,(F^\circ - H^\circ_0)/T. \quad (88)$$

But

$$\Delta(F^\circ - H^\circ_0)/T = \Delta F^\circ/T - \Delta H^\circ_0/T. \quad (89)$$

Since, from equation

$$\Delta F^\circ/T = -R \ln K \quad (90)$$

we have

$$R \ln K = -\Delta H^\circ_0/T - \Delta(F^\circ - H^\circ_0)/T. \quad (91)$$

The value of $\Delta H^\circ_0/T$ for any reaction is obtained from the value at 25°C, which is $\Delta H^\circ_{298.16}$, corrected to 0°K by means of the values of the heat content at 298.16°K, referred to 0°K, for the reactants and products:

$$\Delta H^\circ_0 = \Delta H^\circ_{298.16} - \Delta(H^\circ_{298.16} - H^\circ_0) \quad (92)$$

where

$$\Delta(H^\circ_{298.16} - H^\circ_0) = \Sigma\ (\text{products})\ (H^\circ_{298.16} - H^\circ_0) - \Sigma\ (\text{reactants})\ (H^\circ_{298.16} - H^\circ_0). \quad (93)$$

With the two terms on the right side of equation 91 evaluated as indicated above, the equilibrium constant K can then be evaluated for each of the temperatures of interest.

TABLES OF CHEMICAL THERMODYNAMIC DATA

The calculation of chemical thermodynamic equilibria in chemical reactions is greatly facilitated by the existence of systematic tables giving selected values of the chemical thermodynamic properties of the chemical substances.

The American Petroleum Institute Research Project 44, operating with headquarters at the National Bureau of Standards (under the direction of the writer) and with a unit at the University of California (under the direction of Prof. K. S. Pitzer, at present on leave as director of research of the United States Atomic Energy Commission), is compiling complete tables of the thermodynamic properties of hydrocarbons and related compounds (*23*). To date, this project has issued tables giving values of the following thermodynamic functions:

$(H^\circ - H^\circ_0)/T$, the heat content function
$(F^\circ - H^\circ_0)/T$, the free energy function
S°, the entropy
$H^\circ - H^\circ_0$, the heat content
$C_P{}^\circ$, the heat capacity
ΔHf°, the heat of formation from the elements
ΔFf°, the free energy of formation from the elements
$\log_{10}Kf$, the logarithm of the equilibrium constant of formation from the elements.

In the tables cited (*23*), values for the foregoing functions are given as a function of temperature, usually 0° to 1500°K for the hydrocarbons, but to higher temperatures for the nonhydrocarbons, for the following compounds in the gaseous state:

O, H, N, C.
O_2, H_2, OH, H_2O, N_2, NO, CO, CO_2.
Paraffins, C_1 to C_8, all isomers.
Monoolefins, C_2 to C_6, all isomers.
Diolefins, C_3 to C_5, all isomers.
Acetylenes, C_2 to C_5, all isomers.
Alkyl cyclopentanes, C_5 to C_7, all isomers.
Alkyl cyclohexanes, C_6 to C_8, all isomers.
Alkyl benzenes, C_6 to C_9, all isomers.
Styrenes, C_8 and C_9, all isomers.
Cyclopentene and cyclohexene.
Normal paraffins, C_1 to C_{20}.
Normal monoolefins (1-alkenes), C_2 to C_{20}.
Normal acetylenes (1-alkynes), C_2 to C_{20}.
Normal alkyl cyclopentanes, C_5 to C_{21}.
Normal alkyl cyclohexanes, C_6 to C_{22}.
Normal alkyl benzenes, C_6 to C_{22}.

Similar values are also given for solid carbon (graphite).

For most of the above compounds, the same project has also issued tables giving selected values for the following properties:

Heat of formation, free energy of formation, and entropy, for the liquid state at 25°C.
Heat and entropy of fusion
Heat and entropy of vaporization
Standard heat, entropy, and free energy of vaporization, at 25°C.
Heat of combustion, for the gaseous and liquid states, at 25°C.

With the support of the Office of Naval Research of the United States Department of the Navy, the National Bureau of Standards is also compiling tables of selected values of the chemical thermodynamic properties of the chemical substances (*24*). These tables list substantially the same thermodynamic properties and functions given above but cover all of the chemical substances for which thermodynamic data are available. These tables are being issued in three series, as follows:

Series I: Heat of formation, free energy of formation, logarithm of the equilibrium constant of formation, entropy, and heat capacity, each at 25°C, for solid, liquid, and gaseous states, as appropriate and known. Also, where calculable, the heat of formation of 0°K.

Series II: Heat, temperature, and entropy of transition, fusion, and vaporization, including values of pressure as appropriate and known.

Series III: Heat of formation, free energy of formation, logarithm of the equilibrium constant of formation, free energy function, heat content (or enthalpy) function, entropy, heat content (or enthalpy), and heat capacity, from 0° to high temperatures (in some cases to 5000°K).

The substances listed in the tables are arranged in a manner similar to that used by Bichowsky and Rossini (*25*), with some modification. The chemical elements are arranged in the order shown in Fig. 1. If the elements are taken to be arranged in the order a, b, c, d, e, etc., the chemical substances are in the order: a, b, ba; c, ca, cb, cba; d, da, db, dba, dc, dca, dcb, dcba; etc.

To date, a total of 433 pages of material on selected values of chemical thermodynamic properties has been issued in this work (*24*), including 203 in Series I, 136 in Series II, 79 in Series III, and 15 of constants, conversion factors, and explanatory material. Systematic coverage for Series I and Series II has been completed through the compounds of the mercury group.

EXAMPLES OF CHEMICAL EQUILIBRIA[2]

From the tables of chemical thermodynamic properties mentioned in the preceding section, we can calculate readily the equilibrium constants as a function of temperature for many processes which are important in in the petroleum, chemical, and rubber industries. When the tables give values of $\log_{10}Kf$, the logarithm of the equilibrium constant of formation, for each of the reactants and products of the given reaction, the values of $\log K$ for the reaction may be readily calculated for each temperature of interest, as follows: Given a reaction in which b moles of B react with c moles of C to form m moles of M and n moles of N, as

$$\mathrm{bB} + \mathrm{cC} \doteq \mathrm{mM} + \mathrm{nN}. \qquad (94)$$

Then, for this reaction,

$$\log_{10}K = \Sigma\,(\text{products}) \log_{10}Kf - \Sigma\,(\text{reactants}) \log_{10}Kf \qquad (95)$$

or

$$\log_{10}K = (\mathrm{m} \log_{10}Kf_\mathrm{M} + \mathrm{n} \log_{10}Kf_\mathrm{N}) - (\mathrm{b} \log_{10}Kf_\mathrm{B} + \mathrm{c} \log_{10}Kf_\mathrm{C}). \qquad (96)$$

The values of $\log K$ for a given reaction are then plotted against the temperature in order to ascertain the optimum range of temperature for carrying on the given reaction. Positive values of $\log K$ for a given reaction indicate higher concentrations for the products of the reaction at equilibrium. Negative values of $\log K$ indicate higher concentrations for the reactants at equilib-

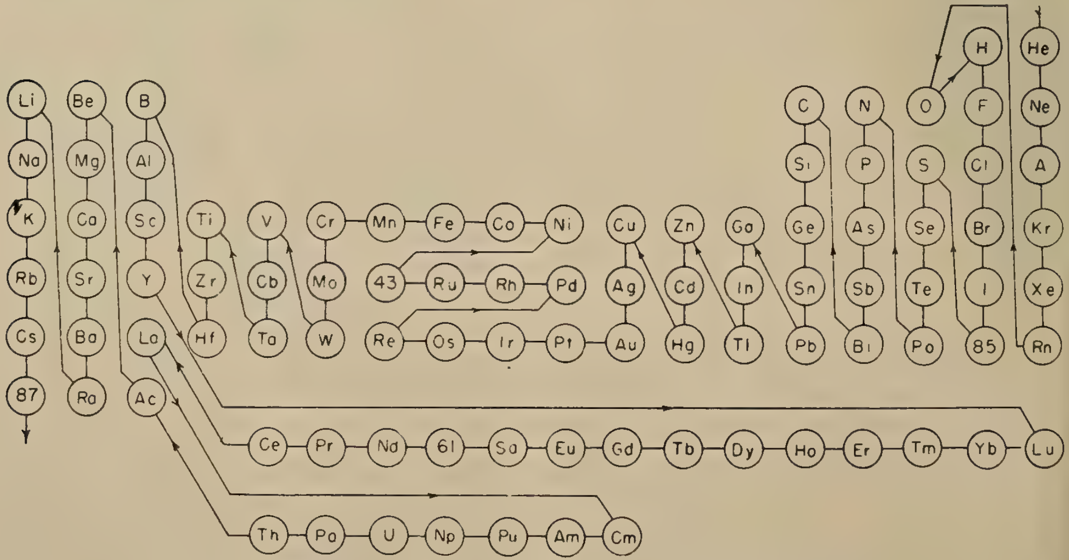


FIG. 1.—Standard order of arrangement of chemical elements.

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[2] Description of the commercial processes mentioned in this section may be found in numerous articles appearing within the past five years in the following journals: Oil and Gas Journal, Petroleum Refiner, and Petroleum Engineer.

rium. Hence, large positive values of log K are required for a reaction to proceed as written.

Toluene for explosives.—During the recent war, the requirements for toluene for use in the manufacture of explosives were far beyond all that could conceivably be produced by the conventional method of recovery from coal tar. The petroleum industry quickly brought two new processes into commercial use, both utilizing petroleum stock and achieving a production greatly in excess of that possible from all the coal tar available.

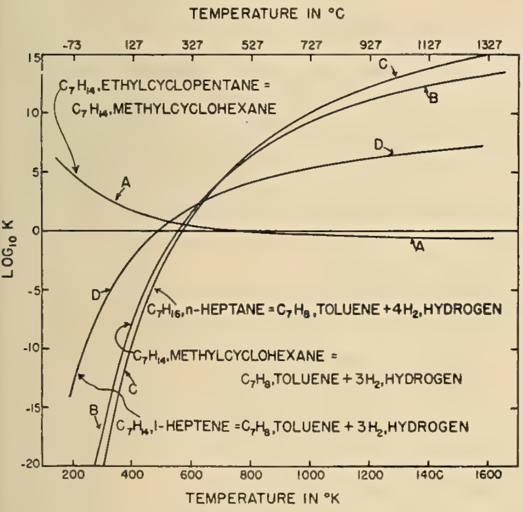

Fig. 2.—Equilibria in reactions involved in the production of toluene from petroleum. The vertical scale gives the value of the logarithm of the equilibrium constant for the given reactions as written, in the gas phase.

In one of the new methods, advantage was taken of the fact that the light gasoline fraction of petroleum contains appreciable amounts of toluene, of methylcyclohexane which can be dehydrogenated to toluene, and of ethylcyclopentane and dimethylcyclopentanes which can be isomerized to methylcyclohexane which can then be dehydrogenated to toluene. All the toluene (including that originally present plus the additional amount formed) is then removed from the other hydrocarbons in the original stock by well established methods of extraction, or azeotropic distillation, or extractive distillation. The reactions involved, are as follows, in the sequence of actual operation:

$$C_7H_{14}\text{ (ethylcyclopentane)} = C_7H_{14}\text{ (methylcyclohexane)} \quad (97)$$

$$C_7H_{14}\text{ (methylcyclohexane)} = C_7H_8\text{(toluene)} + 3H_2\text{(hydrogen)}. \quad (98)$$

Curves A and B in Fig. 2 give the logarithm of the equilibrium constant as a function of temperature for reactions 97 and 98, respectively. Curve A shows that the reaction of isomerization is required to be carried out at low temperatures. Curve B shows that the reaction of dehydrogenation of methylcyclohexane to toluene is required to be performed at higher temperatures. In each case, of course, a suitable catalyst is required.

In the second method for producing toluene from petroleum stock, advantage was taken of the fact that, of the several types of hydrocarbons present in the gasoline fraction of petroleum, the aromatic hydrocarbons (benzene, toluene, xylenes, etc.) are the most stable at high temperatures. The operation here is to pass the mixture of hydrocarbons (paraffins, cycloparaffins, olefins, and aromatics) through a catalytic reaction zone at high temperatures in the presence of hydrogen gas. The several general reactions involve the conversion to aromatics of cycloparaffins, paraffins, and olefins, in accordance with the following representative reactions:

$$C_7H_{14}\text{(methylcyclohexane)} = C_7H_8\text{(toluene)} + 3H_2\text{(hydrogen)} \quad (99)$$

$$C_7H_{16}\text{(n-heptane)} = C_7H_8\text{(toluene)} + 4H_2\text{(hydrogen)} \quad (100)$$

$$C_7H_{14}\text{(1-heptene)} = C_7H_8\text{(toluene)} + 3H_2\text{(hydrogen)}. \quad (101)$$

For each of these reactions, a plot of log K vs T is given in Fig. 2. It may be noted that for each of these reactions in the gas phase the equilibrium is most favorable at high temperatures for the production of toluene. One of the practical problems in such high temperature operations is to reduce the amount of side reactions, particularly decomposition to carbon in the form of coke.

"Isooctane" for aviation fuel.—The mili-

tary need for enormous quantities of "high octane" aviation fuel during the recent war was met in appreciable part by the production of "alkylate" and of "hydrocodimer" materials. These materials were blended with regular aviation fuel base stock to give larger quantities of material of sufficiently high quality when appropriately fortified with tetraethyl lead. The production of these materials, which are largely mixtures of branched-chain octanes, was made possible by the discovery of commercially usable catalysts (sulfuric acid and hydrofluoric acid) which were able to make hydrocarbons, previously considered quite inert, react rapidly at room temperature.

"Alkylate" material is the product obtained when isobutane is added to a mixture of butenes (preferably rich in isobutene) to form a mixture of branched-chain paraffins, largely octanes, but containing appreciable amounts of hexanes, heptanes, and lower-boiling nonanes (*26*). Usually the isobutene is obtained from the gases produced as a byproduct of the cracking process. The amount of isobutane available in natural gasoline is augmented by the isomerization of the larger amount of normal butane present in the natural gasoline. The reactions may be represented as follows:

$$C_4H_{10}(\text{normal butane}) = C_4H_{10}(\text{isobutane}) \quad (102)$$

$$C_4H_{10}(\text{isobutane}) + C_4H_8(\text{isobutene}) = C_8H_{18}(\text{``isooctane''}). \quad (103)$$

The logarithm of the equilibrium constant of these reactions are given as curves A and B, respectively, in Fig. 3. The importance of a suitable catalyst is readily seen from the fact that these reactions must be carried out near room temperature in order to have a favorable equilibrium.

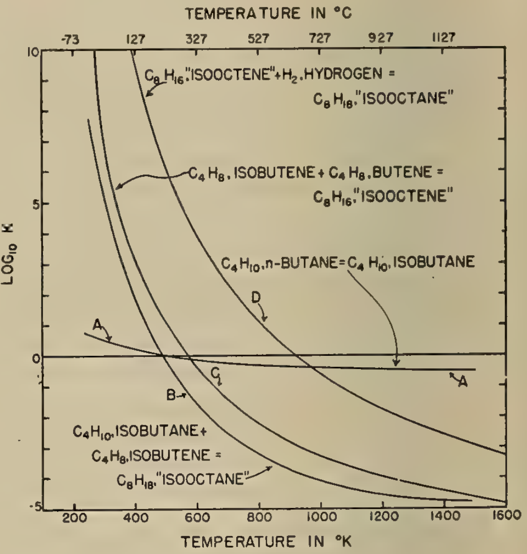

Fig. 3.—Equilibria in reactions involved in the production of "isooctane" for aviation fuel. The vertical scale gives the value of the logarithm of the equilibrium constant for the given reactions as written, in the gas phase.

"Hydrocodimer" material is the product obtained on the hydrogenation of codimers of the butenes. The product is similar to "alkylate" in consisting largely of branched-chain octanes, and containing also branched-chain hexanes, heptanes, and lower-boiling nonanes, but differs in the relative amounts of the main components (*26*). The two reactions may be represented, in principle, as follows:

$$C_4H_8(\text{isobutene}) + C_4H_8(\text{1-butene}) = C_8H_{16}(\text{``isooctene''}) \quad (104)$$

$$C_8H_{16}(\text{``isooctene''}) + H_2(\text{hydrogen}) = C_8H_{18}(\text{``isooctane''}). \quad (105)$$

In Fig. 3, curve B gives the logarithm of the equilibrium constant for reaction 104 and curve C gives that for reaction 105. It may be seen that for both reactions the equilibrium is more favorable at low temperatures.

Butadiene and styrene for synthetic rubber.—One of the most remarkable technological accomplishments in history was the creation in this country during the recent war of a synthetic rubber industry, which was necessitated by the stoppage of the supply of natural rubber. The production of regular synthetic rubber today is largely from petroleum stock through the copolymerization of 1,3-butadiene and styrene.

The 1,3-butadiene is made by the dehydrogenation of butenes obtained from the cracking processes, and the reaction may be represented as follows:

$$C_4H_8(\text{1-butene}) = C_4H_6(\text{1,3-butadiene}) + H_2(\text{hydrogen}). \quad (106)$$

Curve A in Fig. 4 gives the logarithm of the

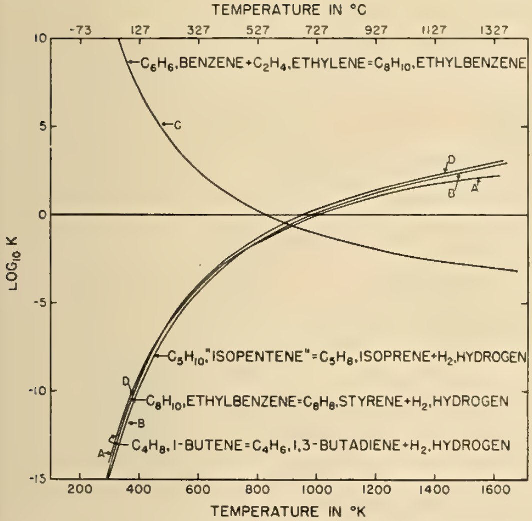

Fig. 4.—Equilibria in reactions involved in the production of components for synthetic rubber. The vertical scale gives the value of the logarithm of the equilibrium constant for the given reactions as written, in the gas phase.

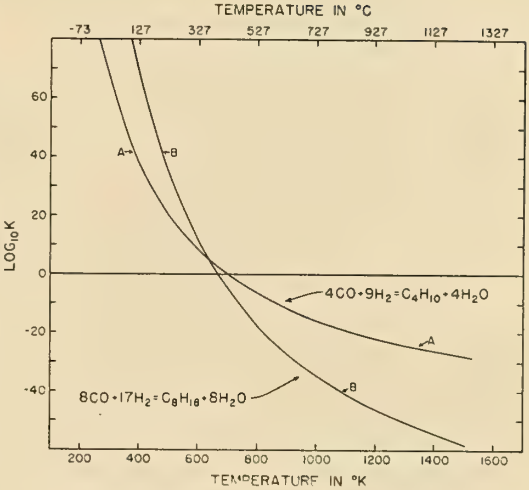

Fig. 6.—Equilibria in reactions involved in the production of synthetic fuels. The vertical scale gives the value of the logarithm of the equilibrium constant for the given reactions as written, in the gas phase.

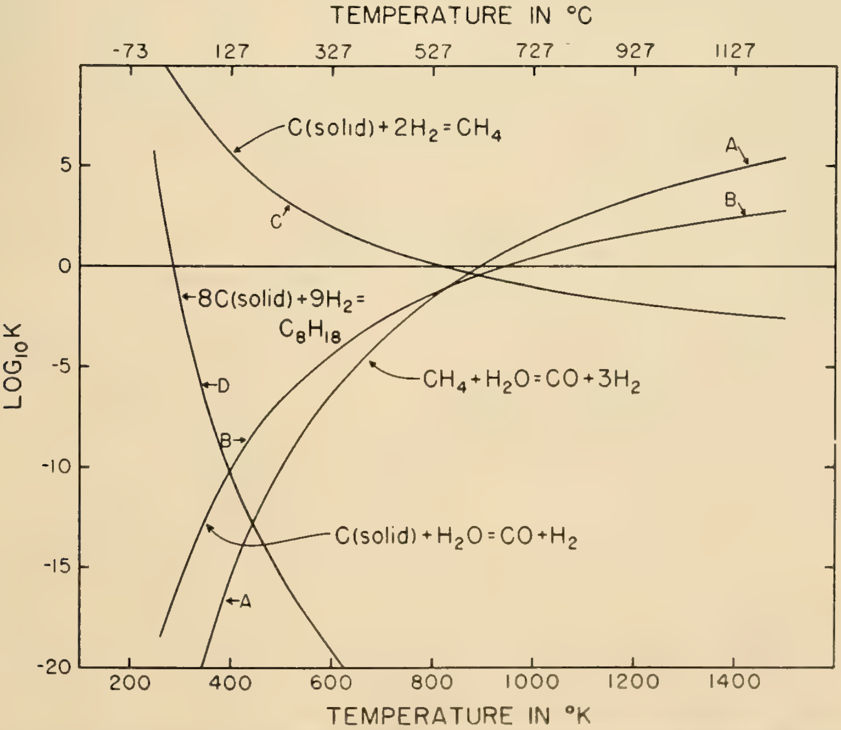

Fig. 5.—Equilibria in reactions involved in the direct synthesis of hydrocarbons and in the production of "synthesis gas" (carbon monoxide plus hydrogen). The vertical scale gives the value of the logarithm of the equilibrium constant for the given reactions as written, in the gas phase except for the solid carbon.

equilibrium constant for this reaction, which may be seen to have a more favorable equilibrium at high temperatures.

The styrene is made by adding ethylene to benzene to make ethylbenzene and then dehydrogenating ethylbenzene to styrene, as follows:

$$C_2H_4\text{(ethylene)} + C_6H_6\text{(benzene)} = C_8H_{10}\text{(ethylbenzene)} \quad (107)$$

$$C_8H_{10}\text{(ethylbenzene)} = C_8H_8\text{(styrene)} + H_2\text{(hydrogen)}. \quad (108)$$

In Fig. 4, curve C gives the logarithm of the equilibrium constant for reaction 107 and curve D gives that for reaction 108. It may be noted that the production of ethylbenzene by reaction 105 must be carried out at relatively low temperatures whereas the dehydrogenation of ethylbenzene to styrene must be carried out at higher temperatures

The copolymerization of 1,3-butadiene and styrene to form "regular" synthetic rubber is performed near room temperature, with newer developments indicating a better product for lower temperatures of polymerization.

Isobutene and isoprene for special synthetic rubber.—Isobutene, C_4H_8, with which is mixed a small amount of isoprene, C_5H_8, is commercially polymerized at low temperatures to form "Butyl" rubber.

The isobutene is obtained from the gases of the cracking process, in which occur appreciable amounts of all four butenes (C_4 monoolefins).

Curve B in Fig. 4 gives the logarithm of the equilibrium constant as a function of temperature for the reaction of dehydrogenation to isoprene of isopentene, C_5H_{10}, which is also obtained from the gases of the cracking process:

$$C_5H_{10}\text{(isopentene)} = C_5H_8\text{(isoprene)} + H_2\text{(hydrogen)}. \quad (109)$$

As is usual with reactions of dehydrogenation, the equilibrium for reaction 109 is more favorable at higher temperatures.

Synthetic fuels.—The reactions for the direct synthesis of gaseous and liquid fuels from carbon and hydrogen have equilibria which are more favorable at low temperatures and suitable catalysts for the commercial operation of such synthesis at low temperatures have not yet been found. Curves C and D in Fig. 5 give the logarithm of the equilibrium constant as a function of temperature for the direct synthesis, from carbon and hydrogen, of methane, CH_4, and octane, C_8H_{18}, respectively:

$$C\text{(solid)} + 2H_2\text{(hydrogen)} = CH_4\text{(methane)} \quad (110)$$

$$8C\text{(solid)} + 9H_2\text{(hydrogen)} = C_8H_{18}\text{(octane)}. \quad (111)$$

However, the synthesis of hydrocarbons can be brought about in two steps, one step involving the formation of "synthesis gas" (carbon monoxide plus hydrogen) from solid carbon and steam and the other step involving the reaction of carbon monoxide and hydrogen to form the hydrocarbon and steam. The formation of the "synthesis gas" may be illustrated by the following reaction:

$$C\text{(solid)} + H_2O\text{(steam)} = CO\text{(carbon monoxide)} + H_2\text{(hydrogen)}. \quad (112)$$

Curve B in Fig. 5 gives the logarithm of the equilibrium constant for this reaction as a function of the temperature and shows that the equilibrium is more favorable at high temperatures.

With an abundance of natural gas, which is largely methane, "synthesis gas" may also be produced as follows:

$$CH_4\text{(methane)} + H_2O\text{(steam)} = CO\text{(carbon monoxide)} + 3H_2\text{(hydrogen)}. \quad (113)$$

Curve A in Fig. 5 applies to the reaction given by equation 113.

Hydrocarbon fuels may be made from the "synthesis gas" by operation at lower temperatures and with suitable catalysts to guide the reaction along the desired path. The following are illustrative reactions:

$$4CO\text{(carbon monoxide)} + 9H_2\text{(hydrogen)} = C_4H_{10}\text{(butane)} + 4H_2O\text{(steam)} \quad (114)$$

$$8CO\text{(carbon monoxide)} + 17H_2\text{(hydrogen)} = C_8H_{18}\text{(octane)} + 8H_2O\text{(steam)}. \quad (115)$$

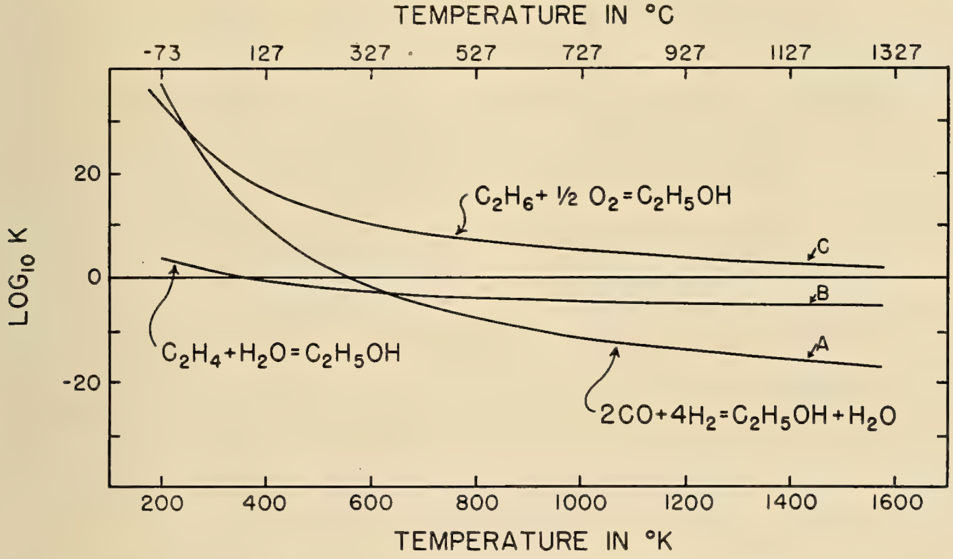

Fig. 7.—Equilibria in reactions involved in the production of synthetic alcohols. The vertical scale gives the value of the logarithm of the equilibrium constant for the given reactions as written, in the gas phase.

Curves A and B in Fig. 6 give the logarithm of the equilibrium constant as a function of the temperature for reactions 114 and 115, respectively. It is seen that the equilibria are more favorable at the lower temperatures for these reactions, which are commonly referred to as "Fischer-Tropsch" reactions.

At the present time, extensive investigations in the field of synthetic fuels are being

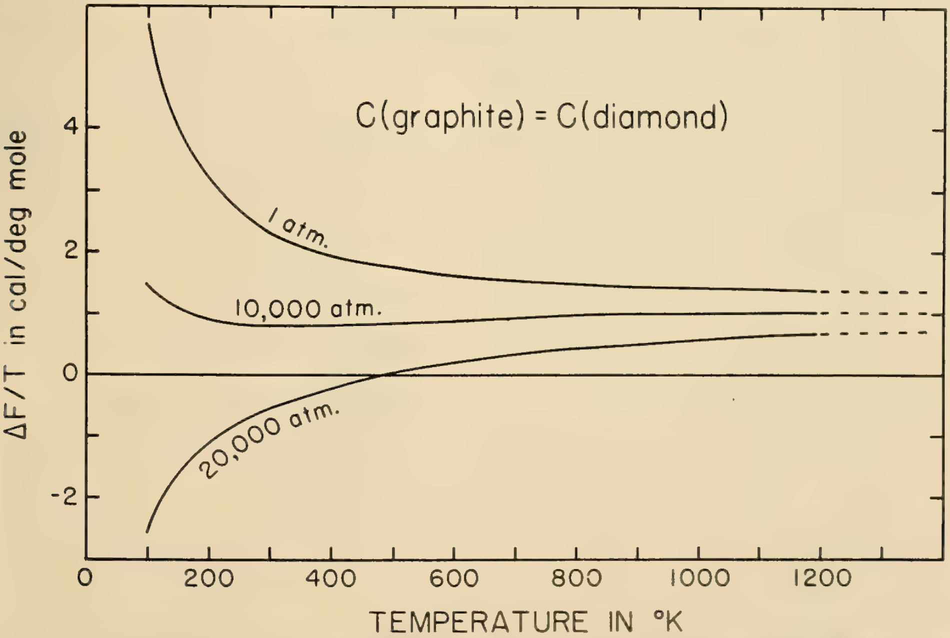

Fig. 8.—Values of $\Delta F/T$ for the conversion of graphite to diamond. The reaction will have a thermodynamic tendency to proceed as written when the value of $\Delta F/T$ is negative. The three curves apply to pressure of 1, 10,000, and 20,000 atmospheres, respectively.

carried out by the U. S. Bureau of Mines and by substantially all the large laboratories in the petroleum industry.

Synthetic alcohols.—By operation with appropriate different catalysts, the same "synthesis gas" may be used to produce alcohols, as illustrated by the following reaction:

$$2CO(\text{carbon monoxide}) + 4H_2(\text{hydrogen}) = C_2H_5OH(\text{ethyl alcohol}) + H_2O(\text{steam}). \quad (116)$$

Curve A in Fig. 7 gives the logarithm of the equilibrium constant as a function of temperature for this reaction, and indicates a more favorable equilibrium at lower temperatures.

With special catalysts, it is possible to add water directly to ethylene to form ethyl alcohol:

$$C_2H_4(\text{ethylene}) + H_2O(\text{steam}) = C_2H_5OH(\text{ethyl alcohol}). \quad (117)$$

Curve B in Fig. 7 applies to this reaction and shows a favorable equilibrium at lower temperatures.

Theoretically, ethane may be oxidized directly to form ethyl alcohol:

$$C_2H_6(\text{ethane}) + \tfrac{1}{2}\,O_2(\text{oxygen}) = C_2H_5OH(\text{ethyl alcohol}). \quad (118)$$

However, this is as yet not a practical reaction because no way has been found to halt the oxidation at this stage in commercial operation. Curve C in Fig. 7 applies to this reaction and shows a more favorable equilibrium at low temperatures, although the equilibrium constant is still favorable even at the higher temperatures. It is likely that the successful control of this reaction will require the development of a special catalyst for operation not far from room temperature.

Transition of graphite to diamond.—Fig. 8 shows the results of some thermodynamic calculations made several years ago (*27*, *28*) on the transition of graphite into diamond. Negative values of $\Delta F/T$ for the transition,

$$C(\text{graphite}) = C(\text{diamond}), \quad (119)$$

correspond to conditions under which the conversion of graphite to diamond would be thermodynamically possible. Of course, for such conditions, a suitable catalyst to make the reaction proceed at a finite rate must still be found. As may be noted from the plot, the conversion of graphite to diamond is favored by low temperatures and high pressures. At room temperature, a pressure of about 15,000 atmospheres is calculated to be necessary to make the conversion thermodynamically possible. As a result of some recent work in his laboratory, Bridgman (*29*) has concluded that at temperatures beyond those shown in Fig. 8 it is possible that the values of $\Delta F/T$ may tend to become negative rather than continuing to increase to greater positive values. If this is true, it is possible that the pressures necessary for the conversion at high temperatures (where the rate of reaction will be adequate) may not be out of the range of attainment.

CONCLUSION

In concluding this discourse on chemical thermodynamics, I would like to recall some words written nearly 30 years ago by Gilbert N. Lewis (*4*) "The fascination of a growing science lies in the work of the pioneers at the very borderland of the unknown, but to reach this frontier, one must pass over well-traveled roads; of these, one of the safest and surest is the broad highway of thermodynamics."

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ENTOMOLOGY.—*Pomerantziidae, a new family of prostigmatic mites.*[1] EDWARD W. BAKER, U. S. Bureau of Entomology and Plant Quarantine.

Upon routine examination of mites collected by W. F. Turner in the course of a survey of the insects in peach orchards in Southern United States, a series of seven specimens was put aside labeled as Stigmaeidae. Recently, while reviewing this family in search of material for a study of the Raphignathidae-Stigmaeidae-Caligonellidae complex, the author noted that these mites possessed genital suckers, which immediately differentiated them from the known related groups. Further examination showed differences in the tarsal claws and tarsal sensory setae, which provide additional support for assigning these mites separate family rank under the present classification. Other variations described are considered as of generic or specific status.

In some cases the existing family classification of the Acarina is based on characters that probably do not justify the family status, and some groups treated as families should be recombined. In other cases single species show such decided systematic breaks that new families must be created. However, the classification of the mites is in such a state of flux that the present system should be considered as a guide rather than as a sound and permanent arrangement.

Pomerantziidae, n. fam.

With palpal thumb-claw complex; movable chelae short, styletlike; peritreme short, not reaching to inner base of chelicerae; several dorsal shields; no eyes; no differentiated sensory setae; anus terminal; three pairs of genital suckers; seven rodlike and one conelike sensory setae on tarsus I; two rodlike sensory setae on tarsus II; tarsi with claws, without pulvilli.

The presence of the three pairs of genital suckers, the large number of sensory setae on tarsus I, and the lack of pulvilli separate this new family from the closely related Raphignathidae-Stigmaeidae-Caligonellidae complex as well as from the Pseudocheylidae, none of which has genital suckers and in all of which there is only one sensory seta on tarsus I. The first group possesses a pulvillus with tenent hairs while the tarsi of the Pseudocheylidae are variously arranged but not as above.

Type genus.—Pomerantzia, n. g.

Pomerantzia, n. g.

Diagnosis as for the family.

Genotype.—Pomerantzia charlesi, n. sp.

Pomerantzia charlesi, n. sp.

Female.—Small, narrow, elongate. Mouth parts (Figs. 1, 2) with palpal thumb-claw complex; palpus slender, of nearly equal size throughout, with few simple setae; palpal claw large, sharp, curved, as long as tibia; a small stout conical spine below claw on tibia; palpal thumb slender narrowing to tip, with about seven simple distal setae; chelicerae fused basally but suture distinct; movable chela short, styletlike, curved, for pierc-

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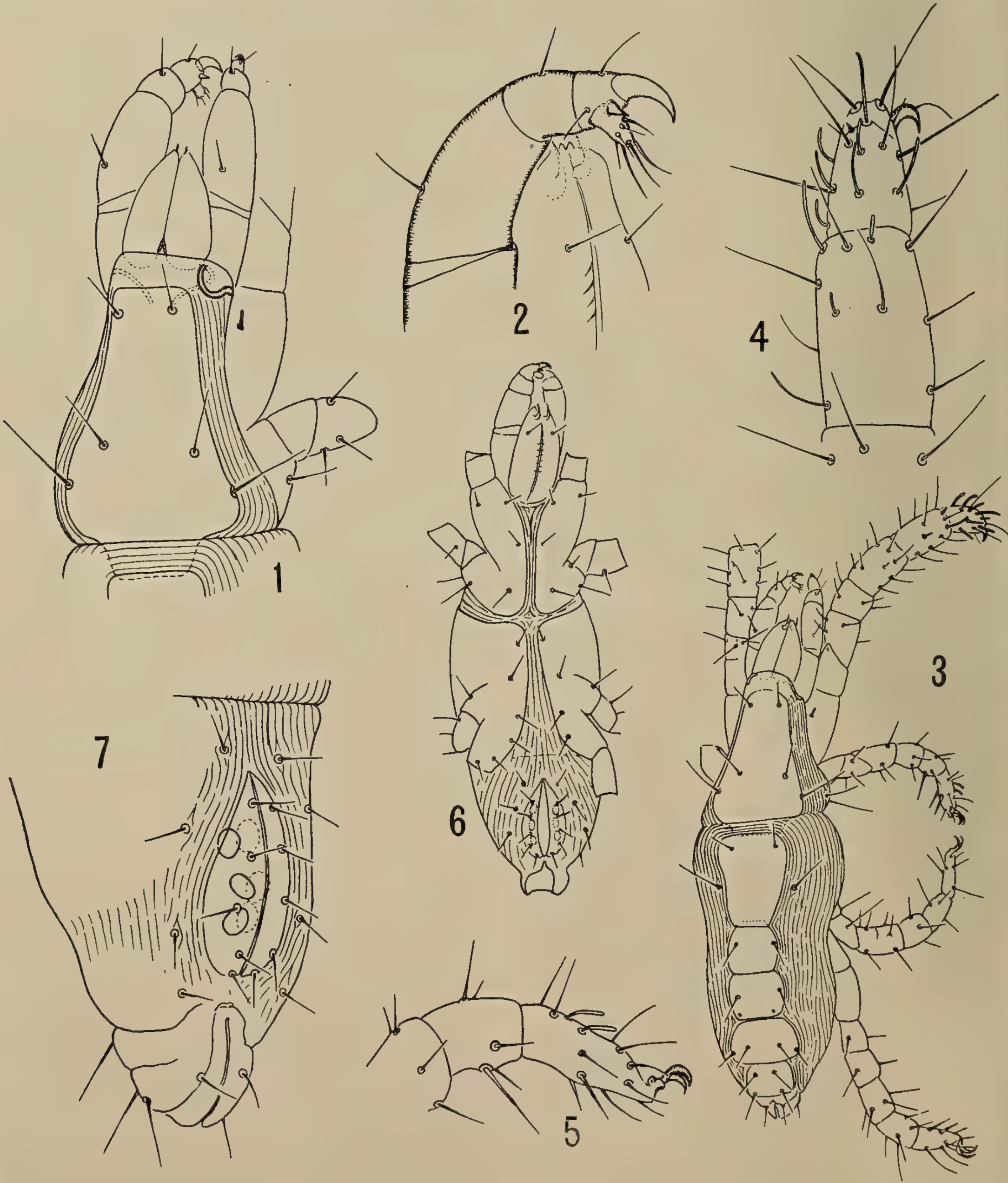
[1] Received March 25, 1949.

ing, typical for the group; at inner posterior corner of cheliceral bases three pairs of small beadlike segments which could be remnants of peritremes; peritremes (Fig. 1) short, on lateral anterior margins of propodosoma, not reaching to inner posterior margin of chelicerae. Single shield on propodosoma, narrowing anteriorly, surrounded by striated skin, with three pairs of setae, none of which appears to be differentiated into sensory setae. No eyes. Dorsum of hysterosoma (Fig. 3) with five small shields, arranged longitudinally; the first three shields each with a single pair of short setae, the posterior two shields each with two pairs of short setae; the third



Figs. 1–7.—*Pomerantzia charlesi*, n. sp.: 1, Anterior dorsal portion showing rostrum, propodosoma, and peritreme; 2, palpus; 3, dorsum; 4, tarsus and tibia I; 5, tarsus and tibia II; 6, venter; 7, detail of genital region.

shield with a pair of posterior marginal pores; shields surrounded by striated skin. Anus terminal. Legs stout, with short setae as figured; tarsi with claws, without pulvilli; tarsus I (Fig. 4) with seven rodlike sensory setae and one short conelike spine; tibia I with three rodlike sensory setae; tarsus II (Fig. 5) with two rodlike sensory setae. Coxae arranged in four groups of two each (Fig. 6), separated by striated skin; coxal plates merging as figured to form a more or less ventral armor; coxa I with a short dorsal rodlike seta. Genitalia (Fig. 7) with three pairs of genital suckers; with five pairs of short setae; venter of mite surrounding genital opening striated, with four pairs of setae. Length including rostrum 340μ; width 100μ.

Types.—Type female, U.S.N.M. no. 1858, and five paratypes, all deposited in the U. S. National Museum.

Type habitat.—In peach orchard soil, Upson County, Ga., collected by W. F. Turner, July 3 and 4, 1936.

This mite is named for Charles Pomerantz, of New York City, in recognition of his enthusiastic services to the study of the rickettsial pox disease, which is carried to man by *Allodermanyssus sanguineus* (Hirst), a mite parasite of mice.

ZOOLOGY.—*Some littoral sea-urchins from the Philippines.*[1] AUSTIN H. CLARK, U. S. National Museum.

The American Museum of Natural History, New York, through John C. Armstrong, has recently sent me for examination a collection of littoral sea-urchins made by Dr. Willard G. Van Name and associates in the Gulf of Dávao, southeastern Mindanao, in 1936 and 1937. I much appreciate the courtesy of the American Museum and of Mr. Armstrong in permitting me to study this interesting collection.

Many species of sea-urchins have been recorded from the littoral of the Philippines, but in very few cases are the records accompanied by definite localities or other data.

In 1928 Dr. Hilario A. Roxas published a list of the littoral species contained in the collection of the Department of Zoology, University of the Philippines. His list included 17 species, but two of these, *Echinometra picta* and *E. oblonga*, are synonyms of *E. mathaei*, the commonest species in the islands. His *Prionocidaris baculosa* is, as has been shown by Mortensen, *Eucidaris metularia*, and his *Toxopneustes chlorocanthus* is *T. pileolus*.

The present list includes only 13 species, but 5 of these are not given in Dr. Roxas's list. These are: *Phyllacanthus imperialis*, *Echinothrix diadema*, *Echinostrephus aciculatus*, *Echinodiscus tenuissimus*, and *Echinoneus cyclostomus*.

Most of Dr. Roxas's specimens came from Puerto Galera, Mindoro. He does not mention any from Mindanao.

CIDARIDAE

Phyllacanthus imperialis (Lamarck)

Locality.—Padada Beach; G. R. Oesch (1 specimen).

Notes.—This is a small specimen 15 mm in diameter with the longest spines 22 mm long. The spines are stoutest in their outer two-thirds. They have two narrow white bands separated by about their own width near the tip. The color is purple.

Plococidaris verticillata (Lamarck)

Localities.—Padada Beach; G. R. Oesch, June 28 to July 8, 1936 (2 specimens and 1 very small broken specimen).

Reef about 1 kilometer north of Digos, Gulf of Dávao; E. H. Oesch and Dr. W. G. Van Name, November 1937 (1 specimen).

Eucidaris metularia (Lamarck)

Locality.—Padada Beach; G. R. Oesch, July 6 to 19, 1936 (2 specimens).

Padada Beach; G. R. Oesch, March 8, 1936 (1 specimen).

DIADEMATIDAE

Diadema setosum (Leske)

Locality.—Padada Beach; G. R. Oesch (1 specimen).

Notes.—The test is 15 mm in diameter and the spines are about 38 mm long. The color is dull red, the spines banded with white. The pedicellariae are typical of this species.

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received March 15, 1949.

Echinothrix diadema (Linné)

Locality.—Reef off Digos, Gulf of Dávao; Ernest H. and G. R. Oesch and Dr. W. G. Van Name, November 1937 (1 specimen).

Echinothrix calamaris (Pallas)

Locality.—Reef about 1 kilometer north of Digos, Gulf of Dávao; E. H. Oesch and Dr. W. G. Van Name, November 1937 (1 specimen).

TEMNOPLEURIDAE

Mespilia globulus (Linné)

Locality.—Padada Beach; G. R. Oesch, May 2, 3, July 6 to 19, 1936 (3 specimens).

ECHINOMETRIDAE

Echinostrephus aciculatus A. Agassiz

Locality.—Reef off Digos, Gulf of Dávao; Ernest H. and G. R. Oesch and Dr. W. G. Van Name, November 1937 (1 specimen).

Echinometra mathaei (de Blainville)

Localities.—Padada Beach; G. R. Oesch, March 8, 14, 16, 19, April 5, 12, May 9, 10, June 5, 6, 20, 21, 25, 26, 28, July 6 to 19, 1936 (91 specimens).

Reef off Digos, Gulf of Dávao; Ernest H. and G. R. Oesch and Dr. W. G. Van Name, November 1937 (4 specimens).

Flats about 1½ miles south of the mouth of the Padada River, Gulf of Dávao; E. H. Oesch and Dr. W. G. Van Name, November 1937 (6 specimens).

Note.—All the specimens from Padada Beach are small.

Heterocentrotus mammillatus (Linné)

Localities.—Padada Beach: G. R. Oesch, June 28 to July 19, 1936 (2 specimens).

One kilometer north of Santa Cruz, Gulf of Dávao; Dr. W. G. Van Name and Felix Barto, November 1937 (4 specimens).

Flats about 1½ miles south of the mouth of the Padada River, near Mangrove Island; E. H. Oesch and Dr. W. G. Van Name, November 1937 (1 specimen).

Reef off Digos, Gulf of Dávao; Ernest H. and G. R. Oesch and Dr. W. G. Van Name, November 1937 (1 specimen).

Notes.—In the specimens from Padada Beach the general color was deep red with lighter bands on the spines, and the secondary spines on the abactinal surface whitish.

A large specimen from north of Santa Cruz was very deep red with lighter red bands on the longer spines; the short secondary spines were not very light colored. A smaller specimen from the same locality was browner and in general lighter colored; the short secondary spines were almost white.

LAGANIDAE

Laganum laganum (Leske)

Localities.—Padada Beach; G. R. Oesch, April 5, 12, May 2, 3, 1936 (52 specimens).

Two kilometers north of Digos, Santa Cruz, Gulf of Dávao; E. H. and G. R. Oesch and Dr. W. G. Van Name, November 1937 (24 specimens).

SCUTELLIDAE

Echinodiscus tenuissimus (L. Agassiz and Desor)

Locality.—Two kilometers north of Digos, Santa Cruz, Gulf of Dávao; E. H. and G. R. Oesch and Dr. W. G. Van Name, November 1937 (1 specimen).

ECHINONEIDAE

Echinoneus cyclostomus (Leske)

Locality.—Not given.

Notes.—This is a large specimen 30 mm. long, 26 mm broad, and 16 mm high.

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ORNITHOLOGY.—*Races of* Pycnonotus cafer (*Linnaeus*) *and* P. aurigaster (*Vieillot*) *in the Indo-Chinese Subregion.*[1] H. G. Deignan, U. S. National Museum.

Through the courtesy of the authorities of the Museum of Comparative Zoology (M.C.Z.), the American Museum of Natural History (A.M.N.H.), the Academy of Natural Sciences of Philadelphia (A.N.S.P.), and the Chicago Natural History Museum (C.N.H.M.), I have added to the series in the United States National Museum (U.S.N.M.) to make a total of 236 Indo-Chinese specimens of the bulbuls combined by Stuart Baker (Fauna of British India, Birds, ed. 2, **7:** 79–80. 1930) into the "species" *Pycnonotus* ("*Molpastes*") *cafer* (Linnaeus).

Baker (*ibid.* **1:** 381–382. 1922) has discussed at some length the problem of overlapping brown-eared forms (*cafer*) and white eared forms (*aurigaster*) in these words:

> The question of the status of the Chinese birds *chrysorrhoides* [= *aurigaster*] is one of some doubt. Robinson and Kloss consider that there are two good species, *chrysorrhoides* [= *aurigaster*] and *haemorrhous* [= *cafer*], both containing one or more races. To me it seems that we have but one species, extending from Ceylon to China, for there is no real break in the continuity of gradation from the dark western forms with black ear-coverts to the pale eastern forms with almost white ear-coverts. At the same time, all along the joining line of *Molpastes h. burmanicus*, *M. h. nigripileus* and *M. h. bengalensis* on the West with *M. h. chrysorrhoides* on the East we have not only many intermediate birds, which might equally well be assigned to either form, but there are many birds, the majority in fact, which can quite definitely be credited to one or the other. Thus there are in the British Museum Collection specimens from the Shan States, Yunnan, Siam, Karenni, Tenasserim, etc., some of which are labelled *chrysorrhoides*, some *nigripileus*, some *atricapillus* and some *klossi* but of the birds so labelled there are many of which it is impossible to say to which race they belong. Davison, Armstrong and others obtained birds at the same place about the same date which they had no difficulty in calling *chrysorrhoides* or *nigripileus*, yet others again are referable to either. It appears to me that all along the Siam-Burmese boundaries there is a narrow region in which there is no stable form found and where, evidently, there are such conflicting conditions in the environment that Nature has not yet had time to evolve one definite form. It is, of course, true that in all lines of demarcation between geographical races intermediate forms are the rule but in this intervening territory intermediate individuals are less common than such as can be definitely assigned to one or the other of the races in the adjoining area.
>
> In view of the many individuals which are exactly half-way between *chrysorrhoides* [= *aurigaster*] and their next-door neighbours, I propose in this work to treat all the forms as geographical races of *haemorrhous* [= *cafer*].

Study of the material before me permits me to agree with Baker's facts, but by no means with his interpretation of them. From Ceylon throughout India to eastern Burma are found a group of clinally intergradient races (*cafer*) characterized by black-to-brown ear coverts, black throat and breast, and scarlet-red under tail coverts; from southeastern China throughout Yunnan, Indochine, and Siam to eastern Burma are found a group of similarly clinally intergradient races (*aurigaster*) characterized by whitish ear coverts, whitish throat and breast, and vermilion, orange, or yellow under tail coverts. Since the members of the two groups show normal clinal intergradation everywhere else, we might expect to find, if they were truly conspecific, in western Yunnan, the Shan States, Karenni, Tenasserim, and western Siam populations in which all individuals would be more or less exactly intermediate between *cafer* and *aurigaster*. This is nowhere the case, as has been observed by Baker in the passage cited above. The idea that "Nature has not yet had time to evolve one definite form" cannot be taken seriously, since perfectly distinct races have evolved immediately east and west of the critical regions.

What in fact seems to occur in western Yunnan, the Shan States, Karenni, Tenasserim, and western Siam is, however, just what might be expected to happen if two not distantly related species make a regular practice of interbreeding and producing fertile hybrids wherever they are sympatric. Only by the adoption of this hypothesis can be explained the occurrence in a single locality on the same date of individuals that might be called *cafer*, *cafer* > *aurigaster*, *cafer* $\lesseqgtr$ *aurigaster*, *aurigaster* > *cafer*, and

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received March 30, 1949.

aurigaster, when, moreover, those that might be called *cafer* > *aurigaster* or *aurigaster* > *cafer* seem to show ever possible ratio of the inheritance of one species to that of the other.

The name "*nigropileus*" (consistently misspelled by Baker) has been bestowed by Blyth (Journ. Asiat. Soc. Bengal **16** (pt. 1): 472. "May" 1847) upon certain Tenasserimese examples that seem to carry *cafer*- and *aurigaster*-inheritance in almost equal parts. This name has been applied also to somewhat similar individuals from the Shan States and western Yunnan; since these last have resulted from the union of races slightly different from the ones concerned in Tenasserim, they are not quite the same as topotypical "*nigropileus.*" In "Remarks" under *Pycnonotus cafer stanfordi* (below) I have given reasons for believing that the more northern hybrids may be called "*burmanicus,*" but it should be understood that I consider "*nigropileus*" and "*burmanicus*" to possess no more standing in zoological nomenclature than "*Vermivora leucobronchialis*" (Brewster), formerly used for what is now known to be a fertile hybrid between two distinct species of wood warblers.

In the discussion of the races of *P. aurigaster* to follow, I have been compelled to adopt a more or less arbitrary sequence, since no linear representation is possible that might reflect the apparent facts of their interrelationships. It seems unquestionable that *germani*, with the feathers of the pileum a pale-edged, unglossed brown, is the one most like the ancestral stock, since this character is well marked in the *juvenal* plumages of other brownish-crowned, yellow-vented forms and is at least indicated in the juvenal plumages of the black-crowned, red-vented races. To judge from the material before me, the true interrelationships are best shown by the accompanying diagram (Fig. 1).

It may be noted again that, while considerable diversity of color appears in the under tail coverts of the races of *aurigaster*, no similar variation is exhibited by *P. cafer*. How fixed is this character in the latter species is indicated by Yen's discovery in the Paris Museum of "un spécimen indien albinos . . . dont les sous-caudales seules restent rouges" (L'Oiseau et Rev. Franç. Orn., n.s., **4** (2): 303. 1934).

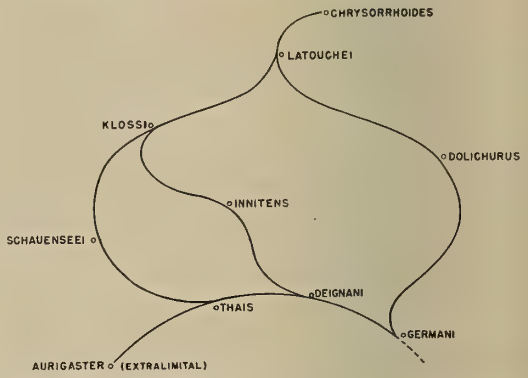

Fig. 1.—Interrelationships among races of *Pycnonotus aurigaster.*

The following Indo-Chinese forms of the two species seem to me to deserve subspecific recognition:

A. PYCNONOTUS AURIGASTER (Vieillot)

1. **Pycnonotus aurigaster chrysorrhoides** (Lafresnaye)

Muscicapa atricapilla Vieillot, Nouveau dictionnaire d'histoire naturelle, nouv. éd., **21**: 489. May 1818 (China), not [*Muscicapa*] *Atricapilla* Linnaeus, 1766.
H[*aematornis*]. *chrysorrhoïdes* Lafresnaye, Revue Zool. **8**: 367. Oct. 1845 (Macao Island, Kwangtung Province, China).
? *Molpastes cafer insularis* Hachisuka, Orn. Soc. Japan Suppl. no. 15: 75. Oct. 30, 1939 (Nauchan, Hainan Island).

Diagnosis.—Crested pileum glossy black; feathers of the upperparts grayish brown, fringed with ashy, slightly paler on the nape and becoming ashy white on the rump; upper wing coverts colored like the back; remiges grayish brown, edged with ashy; rectrices grayish brown, becoming almost black on the apical half, the central pair narrowly, the others broadly, tipped with white; lores, feathers around the eye, chin, and sides of uppermost throat dull black; ear coverts grayish white, sometimes tinged with pale brown, especially posteriorly; underparts pale sullied gray; under tail coverts vermilion-red.

Wing length.—95.2–102.3 mm. (9 males), 91.2–93.4 mm. (3 females) 90.5–101.6 mm. (6 unsexed).

Tail length.—89.7–99.2 mm. (9 males), 82–90.1 mm. (3 females), 85.2–97 mm. (5 unsexed).

Range.—Southeastern China (Fukien, Kwangtung, and Kwangsi Provinces); eastern Tongking; northernmost Annam.

Specimens examined.—China: No definite locality (1 female, 3 unsexed); Fukien Province: Kienyang (2 males), Foochow (1 male), Amoy (1 male); Kwangtung Province: Canton (1 unsexed), Macao (1 unsexed), Hongkong (2 males, 2 unsexed). Tongking: Langson Province: Langson (1 male); Haiphong Province: Cat-Ba Island (1 male). Annam: Thanhhoa Province: Hoixuan (1 male, 2 females), Lunglunh (1 unsexed).

Remarks.—*Molpastes cafer insularis*, based upon one specimen, is not likely to be separable, but whether Hachisuka's name is to be placed in synonymy with *chrysorrhoides* can be decided only by examination of the type.

2. **Pycnonotus aurigaster latouchei**, n. subsp.

Type.—A. M. N. H. no. 417161, adult male, collected at Laichau (elev. 500 feet), Laichau Province, northwestern Tongking, on November 8, 1931, by T. D. Carter (original number 43).

Diagnosis.—From *P. a. chrysorrhoides* readily separable, especially in series, by having the feathers of the upperparts a slightly darker grayish brown, fringed with a slightly darker ashy, so that the race shows a generally deeper tone above.

Wing length.—90–103.5 mm. (23 males), 90.1–98.9 mm. (14 females).

Tail length.—81.6–95.9 mm. (20 males), 82.8–90.3 mm. (14 females).

Range. — Western Tongking; Haut-Laos; southern and western Yunnan; Southern Shan States (Kengtung State); northernmost Siam (Chiang Rai Province, where approaching *klossi*).

Specimens examined. — Tongking: Laokay Province: Ba Nam Nhung (3 females), Baxat (1 male, 1 female); Laichau Province: Muong Moun (1 female), Paham (1 female), Laichau (2 males, 2 females). Laos: 5^e Territoire Militaire: Muong Yo (2 males), Phong Saly (1 male, 2 females). Yunnan: Southeast: Mengtz (7 males 1 female, 1 unsexed); West: Yuankiang (2 males), Likiang Range (1 female). Southern Shan States: Kengtung State: Loi Mwe (6 males, 3 females), Pang Hsang (1 male), Mong Pek (1 male, 1 female). Siam: Chiang Rai Province: Chiang Saen Kao (1 male), Banchong Mountains (1 male), Chiang Rai (1 female).

Remarks.—That the distinguishing character of this race was noted long ago by La Touche is made evident by his choice of an unpublished manuscript name inscribed on the label of a "type" from Mengtz. Since the name in question has since been used for an Indian form of *P. cafer* I take pleasure in dedicating the new race to La Touche's memory.

3. **Pycnonotus aurigaster klossi** (Gyldenstolpe)

Molpastes atricapillus klossi "Robinson," error = Gyldenstolpe, Bull. Brit. Orn. Club **41**: 12. Nov. 9, 1920 (Doi Khun Tan, northern Siam at lat. 18°30′ N., long. 99°20′ E.); **42**: 32. Nov. 29, 1921.

Diagnosis.—A poorly defined race, distinguishable in series from the two precedent forms by having the general tone of the upperparts rather more brownish gray than grayish brown, by lesser average measurements, and by its somewhat shorter crest.

Wing length.—86.5–94.9 mm. (8 males), 83.3–90.8 mm. (12 females), 88.1–89.5 mm. (2 unsexed).

Tail length.—76.2–86.3 mm. (8 males), 72.5–85.1 mm. (12 females), 77.4–78 mm. (2 unsexed).

Range.—Tenasserim (Toungoo to Amherst Districts); Karenni; northern Siam (excepting Chiang Rai Province), south on both east and west to about lat. 16°45′ N. (where approaching *innitens* and *schauenseei*); probably adjacent parts of Laos (Vientiane Province).

Specimens examined.—Tenasserim: Toungoo District: Thandaung (1 male); Salween District: Yunzalin River (1 male); Thaton *or* Amherst District: Thaungyin River (1 male, 1 female); Amherst District: Mepale (1 female), Myawadi (1 female). Siam: North: Ban Rahaeng (1 female, 1 unsexed), Ban Mae Tha Khwae (1 female), Ban Wiang Tai (1 female), Ban Hua Pa Phai (1 male), Doi Chiang Dao (1 male, 1 female), *ca.* 30 miles N. of Chiang Mai (1 male), Ban San Maha Phon (1 male), Doi Suthep (1 male, 3 females) Chiang Mai (1 male, 2 females), Doi Ang Ka (1 male), Doi Khun Tan (3 males, 1 female, 1 unsexed), Ban Bo Kaĕo (1 female), Ban Mae Lam Phan (1 male, 1 female).

4. **Pycnonotus aurigaster schauenseei** Delacour

Pycnonotus cafer schauenseei Delacour, Zoologica **28** (pt. 1): 29. May 4, 1943 (Ban Si Sawat, southwestern Siam at lat. 14°40′ N., long. 99°02′ E.).

Diagnosis.—A somewhat unstable race, nearest *klossi*, from which it is separable by lesser average measurements, by lesser development of the crest, by having the upperparts slightly browner in general tone, by having the light tips of the rectrices less extensive and tinged with ashy, and by having the under tail coverts varying in hue between rosy red and red-orange.

Wing length.—82.8–92 mm. (5 males), 80.2–87.5 mm. (3 females), 92 mm. (1 unsexed).

Tail length.—74.6–87.5 mm. (5 males), 75–82.2 mm. (3 females), 84 mm. (1 unsexed).

Range.—Southwestern Siam (valley of the Mae Klong from its head [where approaching *klossi*] to about lat. 14° N.); Tenasserim (Amherst and Tavoy Districts).

Specimens examined.—SIAM: Southwest: 53 miles E. of Ban Um Phang (2 males, 1 female, 1 unsexed), Ban Si Sawat (2 males, 2 females). TENASSERIM: Amherst District: Lampha (1 female).

5. **Pycnonotus aurigaster thais** (Boden Kloss)

Molpastes aurigaster thais Boden Kloss, Journ. Nat. Hist. Soc. Siam 6 (3): 291. July 15, 1924 (Bangkok, central Siam at lat. 13°45′ N., long. 100° 30′ E.).

Diagnosis.—From *P. a. schauenseei* separable only by having the under tail coverts bright Cadmium Yellow (Ridgway).

Wing length.—86.3–92 mm (4 males).

Tail length.—76–78.8 mm. (3 males).

Range.—Southwestern Siam, south of the range of *schauenseei* and extending east along the coast to Bangkok.

Specimens examined.—SIAM: Southwest: Ban Tha Muang (2 males), Rat Buri (1 male), Bangkok (1 male).

6. **Pycnonotus aurigaster innitens, n. subsp.**

Type.—U.S.N.M. no. 307019, adult female, collected at Ban Pak Chong, eastern Siam, at lat. 14°40′ N., long. 101°25′ E., on February 7, 1925, by Hugh McC. Smith.

Diagnosis.—Nearest *P. a. schauenseei*, but differing by having the black pileum almost without gloss, especially anteriorly, where it tends to become a brownish black or blackish brown; by having the general tone of the upperparts perhaps very slightly browner; and by having the under tail coverts Scarlet-Red (1 specimen) or Peach Red (8 specimens), as these colors are understood by Ridgway.

From *P. a. klossi* separable by its less highly developed crest and by the almost wholly unglossed pileum; by having the light tips of the rectrices less extensive and tinged with ashy; by the paler reds shown by the under tail coverts; and by slightly lesser average measurements.

Wing length.—86.6–91.7 mm. (4 males), 83.4–88.3 mm. (5 females).

Tail length.—74.5–78.7 mm. (4 males), 70.6–75.3 mm. (5 females).

Range.—The southern end of the chain of hills dividing the Chao Phaya system from that of the Mae Khong (Ban Pak Chong); the southwestern portion of the plateau of eastern Siam (Ban Bua Yai); the country between this plateau and "Southeastern Siam" (Nakhon Nayok, Kabin Buri); southeastern Siam (Ban Si Racha).

Specimens examined.—SIAM: Southeast: Ban Bua Yai (1 female), Ban Pak Chong (1 male, 1 female), Nakhon Nayok (2 males), Kabin Buri (1 female), Ban Si Racha (1 male, 2 females).

Remarks.—As *P. a. schauenseei* represents the intergrade between red-vented *klossi* and yellow-vented *thais*, this form represents the corresponding intergrade on the other side of the central Siamese plain between *klossi* and the yellow-vented *deignani*. *Pycnonotus a. innitens* seems to occur only in isolated populations, and it is of especial interest to find that along a limited stretch of the coast of the Gulf of Siam one finds yellow-vented *thais* at Bangkok, red-vented *innitens* at Ban Si Racha, and yellow-vented *deignani* at Chanthaburi.

7. **Pycnonotus aurigaster deignani** Delacour

Pycnonotus cafer deignani Delacour, Zoologica **28** (pt. 1): 29. May 4, 1943 (Chanthaburi, southeastern Siam at lat. 12°35′ N., long. 102°05′ E.).

Diagnosis.—From *P. a. innitens* separable only by having the under tail coverts Primuline Yellow (Ridgway).

From *P. a. thais* separable by having the black pileum almost without gloss, especially anteriorly where it tends to become a blackish brown.

Wing length.—84.8–90.8 mm. (4 males), 81.4–86.4 mm. (2 females).

Tail length.—72.8–78.9 mm. (4 males), 69.8–75.2 mm. (2 females).

Range.—Southeastern Siam (Chanthaburi).

Specimens examined—SIAM: Southeast: Chanthaburi (6 males, 2 females).

8. **Pycnonotus aurigaster germani** (Oustalet)

Ixus Germani Oustalet, Bull. Soc. Philom. Paris, ser. 7, **2** (1): 54. 1878 (Saigon, Cochinchine).

Diagnosis.—Nearest *P. a. deignani*, but easily separable in the adult by having the pileum almost devoid of a crest and with each brownish-black or blackish-brown feather narrowly edged with a lighter brown (exactly as in the immature of *deignani*).

Wing length.—88–92 mm. (10 males), 84–88.5 mm. (14 females), 86–89.2 mm. (2 unsexed).

Tail length.—74.6–81.2 mm. (10 males), 73.1–78 mm. (13 females), 76.1–79.2 mm. (2 unsexed).

Range. — Cochinchine; southern Annam; Bas-Laos; extreme eastern Siam (along the Mae Khong in Ubon Province).

Specimens examined.—Siam: East: Ban Chanuman (2 males, 5 females), Ban Khulu (2 males, 1 female). Bas-Laos: Pakse Province: Pakse (1 male); Saravane Province: Phu Tongtoul (1 female). Annam: Phanrang Province: Krongpha (2 males), between Bellevue and Daban (1 female), Fimnon (1 male, 5 females, 2 unsexed), Daban (1 male), Dran (2 males, 2 females), Dalat (1 female), between Dalat and Ban Methuot (2 females), 35 kilometers south of Dalat (2 males), 50 kilometers southeast of Dalat (2 males).

9. **Pycnonotus aurigaster dolichurus,** n. subsp.

Type.—C.N.H.M. no. 79300, adult male, collected at Phuoc, Quangtri Province, central Annam, on January 25, 1929, by J. Van Tyne (original number 68).

Diagnosis.—Nearest *P. a. chrysorrhoides* (which reaches northern Annam), but separable by shorter wing length and by having the black pileum virtually unglossed.

From *P. a. innitens,* which it resembles in the coloration of the under tail coverts, distinguishable by its more highly developed crest, by longer wing and much longer tail measurements, and by having the light tips of the rectrices broader and whiter.

Wing length.—92.3–95.3 mm. (6 males), 86.7–87 mm. (2 females).

Tail length.—85.5–99.7 mm. (6 males), 80.6–83.1 mm. (2 females).

Range.—Central Annam.

Specimens examined.—Annam: Quangtri Province: Phuoc (6 males, 2 females).

Remarks.— *P. a. dolichurus* represents the intermediate population between red- and yellow-vented birds along the coast of Annam, as *P. a. innitens* does in southeastern Siam and *P. a. schauenseei* in southwestern Siam. It is, however, a considerably larger form than either of the other two.

B. PYCNONOTUS CAFER (Linnaeus)

1. **Pycnonotus cafer stanfordi,** n. subsp.

Type.—A.M.N.H. no 409420, adult male, collected at Taro *or* Dalu (lat. 26° 20′ N., long. 96° 10′ E.), Upper Chindwin District, Sagaing Division, Burma, on February 10, 1935, by members of the Vernay-Hopwood Chindwin Expedition (original number 321).

Diagnosis.—Similar to *Pycnonotus aurigaster latouchei* (with which westerly it is cohabitant), but differing by having the dark centers of the feathers of the upperparts more clearly defined; the ear coverts hair brown; the chin and throat black, this color changing to blackish brown on the breast, of which the lateral and posterior feathers are broadly fringed with ashy; the undertail coverts a deeper Scarlet-Red (Ridgway).

Wing length.—96.8-105.7 mm. (15 males), 94–97.2 mm. (4 females), 98.5 mm. (1 unsexed).

Tail length.—81–97.2 mm. (15 males), 84.2–89.3 mm. (3 females), 86.4 mm. (1 unsexed).

Range.—Northern Burma (Pakkoku, Lower Chindwin, Upper Chindwin, Myitkyina, Bhamo Districts); Yunnan (west); Northern Shan States

Specimens examined.—Yunnan: West: Manhsien (1 female), Tengyueh (4 males, 2 females). Burma: Myitkyina District: Washaung (1 female), Chipwi (1 male), Seniku-Sh'ngaw road (1 male), Lonkin (1 male); Bhamo District: Bhamo (2 males); Upper Chindwin District: Taro (2 males), Namyaseik (1 male); Lower Chindwin District: Aingma (1 male), "Moungon" (1 male); Pakkoku District: Kyundaw (1 unsexed). Northern Shan States: Hispaw State: Chaungzon (1 male).

Remarks.—This race, named in honor of the well-known authority on Burmese birds, J. K. Stanford, has, by the most recent writers (Stanford and Mayr Ibis, 1941: 103; Stanford and Ticehurst, Ibis, 1938: 214; Mayr, *ibid.*: 291), been called *burmanicus* of Bowdler Sharpe (Catalogue of the birds in the British Museum **6:** 125. 1882).

Sharpe designated no specimen as type, but stated that the form ranged "from Cachar into Pegu," and listed six examples from northeastern Burma, western Yunnan, and Pegu (no British Museum bird from Cachar).

Since series before me from Cachar, northeastern Burma, western Yunnan, and Pegu show that Sharpe had combined under one name no less than three geographical races and one interspecific hybrid, I have been compelled to decide, on the basis of his written description, to which of these the name must be applied.

Sharpe's statement, "the hinder neck coloured like the back, but more distinctly ashy," immediately removes from consideration the population of Cachar, which has the hind neck darker than the back, nigrescent and not trenchantly defined from the pileum.

Other statements, "Above light brown . . . the lower back and rump uniform ashy . . . the hinder neck coloured like the back, but more distinctly ashy . . . ear-coverts ashy brown," further restrict the use of the name to birds of northeastern Burma and western Yunnan, where, however, the problem is complicated by the presence of hybrids. But the further statement, "fore neck and breast light brown," seems to show without question that one of these hybrids must be considered typical of *burmanicus*, since the full-blooded birds that I have named *stanfordi* have this area ranging from black to blackish brown, while the hybrids, in fact, show a color that might well be described as "light brown." These hybrids have in the past been called "*nigropileus*," but they are considerably larger and more richly colored everywhere than topotypical "*nigropileus*" from Tenasserim, and, if it should prove desirable, the name "*burmanicus*" may be used for them, although, as I have stated in my introductory remarks, these names should not be thought to possess standing in zoological nomenclature.

It may be suggested that I have for legalistic reasons discarded a name previously considered available, but it seems certain that careful comparison of specimens with Sharpe's description will show that there is no alternative action. In naming the population of northeastern Burma I have selected a type locality well without the area in which hybrid individuals are ever likely to occur.

2. **Pycnonotus cafer melanchimus**, n. subsp.

Type.—A.M.N.H. no. 568717, adult male, collected at Rangoon, Rangoon Town District, Pegu Division, Burma, on January 2, 1906, by H. H. Harington (original number 279), *ex* Rothschild Museum.

Diagnosis.—Nearest *P. c. stanfordi*, but distinguishable by having the feathers of the upperparts with darker centers and more narrowly edged with ashy, so that the general tone of the back is deeper; the ear coverts a deeper hair brown; the blackish-brown coloration of the anterior underparts extending onto the abdomen, with resultant decrease of the ashy-white area below; possibly also by having the white tips to the rectrices less extensive in unworn plumage.

Wing length.—93.8–99 mm. (4 males), 87.2 mm. (1 female).

Tail length.—85.1–90.4 mm. (4 males), 79.2 mm. (1 female).

Range.—Sourthern Burma (Thayetmyo, Pegu, Rangoon Town Districts), perhaps restricted to the country between the Irrawaddy and Sittang Rivers, so far as this lies south of *ca.* lat. 20° N.

Specimens examined.—BURMA: Thayetmyo District: Kyaukpadaung (1 male); Pegu District: Zaingganaing (1 male); Rangoon Town District: Rangoon (2 males, 2 females).

Remarks.—A single specimen (male?) from lat. 19° 25′ N., long. 94° 40′ E. (near Mindon at the eastern foot of the Arakan Yoma in the Thayetmyo District) agrees very well in color with *P. c. stanfordi*, but has the narrow tail tips and small measurements of *melanchimus* (wing: 90.2 mm.; tail: 80.3 mm.). For the present this individual cannot be identified to subspecies.

3. **Pycnonotus cafer primrosei**, n. subsp.

Type.—U.S.N.M. no. 253767, adult male, collected at the Surma Tea Estate, southern Sylhet District, Surma Valley and Hill Division, Assam Province, India, on January 1, 1900, by A. M. Primrose.

Diagnosis.—Near *P. c. standfordi*, but easily distinguished therefrom and from all other precedent forms by having the nape and sometimes the upper back black or at least blackish, so that the pileum is not at all clearly defined from the mantle.

Near *P. c. pygaeus* (see below), but distinguishable from it by having the ear coverts hair brown of the same tone as in *P. c. stanfordi*.

Wing length.—95–104 mm. (8 males), 95.9–106 mm. (4 females).

Tail length.—82.7–94.2 mm. (7 males), 83–98.1 mm. (4 females).

Range.—Assam (Goalpara, Garo Hills, Sylhet, Cachar, and probably still other districts south of the Brahmaputra River).

Specimens examined.—ASSAM: Goalpara District: Goalpara (1 male); Garo Hills District: Tura (2 females); Sylhet District: Surma Tea Estate (1 male), Rena Tea Estate (1 female); Cachar District: Laisung (1 male), Mahur (1 male), Guilang (1 male), Gunjong (3 males, 1 female).

Remarks.—Birds from the Goalpara and Garo Hills Districts are approaching *pygaeus*; a single unsatisfactory specimen from the Patkai Hills seems to be nearer *stanfordi* than *primrosei*.

This race is named in honor of the collector, A. M. Primrose.

4. **Pycnonotus cafer pygaeus** (Hodgson)

[*Ixos*] *pygæus* Hodgson, *in* J. E. Gray, Zoological Miscellany, no. 3: 84. "June" 1844 (Nepal).

P[*ycnonotus*]. *bengalensis* Blyth, Journ. Asiat. Soc. Bengal **14** (pt. 2): 566 and footnote. Aug. 1845 (Bengal).

Ixos cafer? v[el]. *pygmæus* 'Hodgs." J. E. Gray, Catalogue of the specimens and drawings of Mammalia and birds of Nepal and Thibet: 89. 1846 (Nepal).

I[*xos*]. *pygaeus* "Hodgson" Bonaparte, Conspectus generum avium **1**: 265. 1850 ("ex Him. Assam, Bengal").

Pycn[*onotus*]. *pseudocafer* "Blyth" Bonaparte, Conspectus generum avium **1**: 265. 1850. *Nomen nudum*, in synonymy with *I*[*xos*]. *pygaeus* "Hodgs." Bonaparte ("ex Him. Assam, Bengal").

Diagnosis.—Nearest *P. c. primrosei*, from which it is certainly distinguishable only by having the ear coverts a deeper hair brown of the same tone as in *P. c. melanchimus*.

Wing length.—98.2–104.3 mm. (6 males), 92.4–103.8 mm. (6 unsexed).

Tail length.—88.2–96.7 mm. (4 males), 86.5–93.6 mm. (5 unsexed).

Range.—Nepal; Sikkim; eastern United Provinces: Bihar; Bengal; Assam (hills north of the Brahmaputra River); Fiji Islands (introduced into Viti Levu).

Specimens examined.—Nepal: No definite locality (1 unsexed); Sikkim: No definite locality (2 unsexed). "India": No definite locality (1 unsexed). United Provinces: Kheri District: North Kheri Forest (1 male); Partabgarh District: Partabgarh (1 male); Bengal: No definite locality (1 unsexed); Darjiling District: Sangsir (1 male), Siliguri (1 male), Mangpu (2 males, 1 unsexed). Fiji Islands: Viti Levu: no definite locality (1 female), Rewa River, 30 miles inland (1 male), 4 miles from Suva (1 unsexed).

Remarks.—Under [*Ixos*] *pygæus* Hodgson, 1844, we find "*Ixos cafer?* v[el]. *pygœus*, 207." This seems by the narrowest margin to validate the name from 1844; if, however, the reference is rejected, this form must be called *Pycnonotus cafer bengalensis* Blyth, 1845.

PROCEEDINGS OF THE ACADEMY

428TH MEETING OF BOARD OF MANAGERS

The 428th meeting of the Board of Managers, held in the Cosmos Club, May 16, 1949, was called to order at 8:05 p.m. by the President, F. H. H. Roberts, Jr. Others present were: F. B. Silsbee, H. S. Rappleye, H. A. Rehder, Alan Stone, W. W. Diehl, F. M. Defandorf, C. L. Gazin, F. E. Johnston, F. D. Rossini, J. B. Reeside, Jr., W. A. Dayton, C. A. Betts, R. S. Dill, A. O. Foster, O. B. French, and, by invitation, H. E. McComb, J. L. Shereshefsky.

The chairman of the Committee on Membership, H. E. McComb, presented eight nominations for resident membership.

The chairman of the Committee on Grants-in-Aid for Research, J. L. Shereshefsky, announced that funds available for grants-in-aid from the American Association for the Advancement of Science now amounted to $596.50, accumulated as follows: $163.00 from 1947, $213.00 from 1948, and $220.50 for the current year 1949. It was noted that the $163.00 from 1947 must be specifically committed by December 31, 1949, or this amount would be lost to the Academy for this purpose. The chairman of the committee recommended that announcement be made of the availability of these funds to research, specifically that the Secretary by letter so inform the various affiliated societies and that published announcement be made in the July and September issues of the Journal. It was further stipulated that the final date for receiving applications this year would be November 1. The recommendation was accepted by the Board.

The Secretary announced the following deaths: Whitman Cross, former director of the U. S. Geological Survey, original member of the Academy, on April 20, 1949 (elected March 17, 1898); Orator F. Cook, formerly with the Bureau of Plant Industry, U. S. Department of Agriculture, original member, on April 23, 1949 (elected March 17, 1898); Philip S. Smith, formerly with the U. S. Geological Survey, on May 10, 1949 (elected January 18, 1912).

The Custodian and Subscription Manager of Publications, Harald A. Rehder, announced that the Academy had recently received an almost complete set of the Journal, lacking but 21 numbers, from Fred H. Moffit. It was also announced that 7 copies of the monograph had been sold.

The President announced receipt of the following letter from Frank Thone, the Academy's representative on the Joint Committee on Press Relations:

> Pursuant to our recent telephonic discussions of the status of the Science Calendar which Mr. Darnell has been preparing for local newspapers, he has written me a letter to place on record his transactions with the Council, and his intention of carrying on the program by himself—with, of course, the little assistance I am able to give him.
>
> This is for your information, and transmittal to Dr. Setzler for his files.
>
> Mr. Darnell adds, in a hand-written note: "I find we have sufficient funds to carry us through June of this year."

The Secretary was then requested by the President to read the letter which Frank Thone received from Richard C. Darnell.

After some discussion of the background of the subject of Mr. Darnell's letter, it was proposed and approved that a conference be arranged between the President or a committee from the Academy and the D. C. Council of Engineering and Architectural Societies to discuss ways and means of continuing the Science Calendar.

The meeting was adjourned at 8:58 P.M.

C. LEWIS GAZIN, *Acting Secretary.*

Obituary

RICHARD CHACE TOLMAN was born in West Newton, Mass., on March 4, 1881. His undergraduate college work was undertaken at Massachusetts Institute of Technology, and he also obtained there in 1910 the degree of Ph.D. During the preceding three years he was a member of that now famous group of physical chemists that the late Prof. A. A. Noyes gathered around him. This group included such notables as G. N. Lewis, E. W. Washburn, W. C. Bray, John Johnston, and others, all of whom through the inspiring example of Professor Noyes committed themselves to physical chemistry as their career and made outstanding contributions in that field.

After leaving M.I.T., Dr. Tolman held positions successively on the faculties of the Universities of Michigan, Cincinnati, California, and Illinois. During World War I he entered the Chemical Warfare Service with the rank of major; and following the end of the war was associate director and then director of the Fixed Nitrogen Research Laboratory. In 1922 he went to the California Institute of Technology as professor of physical chemistry and mathematical physics; and in 1935 became dean of the graduate school, a position he held until his death on September 5, 1948.

During World War II he was chosen by Dr. Vannevar Bush to be a member of the newly constituted National Defense Research Committee, and he functioned as vice chairman of that important body until its dissolution at the war's end. He served as an adviser to Maj. Gen. Leslie Groves in connection with the famous Manhatten Project; and in 1946 he accepted an appointment as scientific adviser to the United States representative to the United Nations Atomic Energy Commission.

Besides being a member of the Washington Academy of Sciences, Dr. Tolman was a member or a fellow of many other scientific societies, including the National Academy of Sciences, American Chemical Society, American Philosophical Society, American Physical Society, Optical Society of America, American Academy of Arts and Sciences, and American Association for the Advancement of Science.

He is best known for his investigations on colloids, relativity, similitude, the mass of the electron, the nature of the fundamental quantities of physics, the partition of energy, the behavior of smokes, the electric discharge in gases, the reactions of nitrogen compounds, the rate of chemical reaction, the specific heat and entropy of gases, the quantum theory, statistical mechanics, relativistic thermodynamics, cosmology, ionization, and metallic conductors.

He is author of many articles published in various scientific journals and of several books including the following: *The theory of the relativity of motion*, published in 1917; *Statistical mechanics with applications to physics and chemistry*, published in 1927; *Relativity, thermodynamics and cosmology*, published in 1934; and *The principles of statistical mechanics*, 1938.

Dr. Tolman's passing is a great loss to the scientific world and is felt keenly by all who knew him. He was a broad-minded scholar, a great teacher, and an outstanding investigator. Above all, he was endowed with those qualities of tact, sympathy, and understanding that endeared him to his students and his colleagues.

LEASON H. ADAMS.

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Vol. 39 September 15, 1949 No. 9

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

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JOURNAL
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VOLUME 39 SEPTEMBER 15, 1949 No. 9

PHYSICS.—*Contributions of electricity to mechanics.*[1] WALTER RAMBERG, National Bureau of Standards.

The title of this address stems from the observation of the speaker that a surprising number of his colleagues in the field of mechanics received their first professional training in electricity, either as electrical engineers or as physicists specializing in electricity. This observation receives quantitative support from the educational records of the authors contributing papers to the leading American journal in the field of applied mechanics, the *Journal of Applied Mechanics* of the American Society of Mechanical Engineers. An attempt was made to find the educational records of the authors for two recent years of the journal, 1946 and 1947, by reference to *Who's Who in Engineering* for 1948 and *American Men of Science* for 1944. The records were found for the authors of only 28 among the 77 papers printed in these two years. Only 29 per cent of the 28 papers came from authors with an orthodox training in mechanical engineering; 16 per cent came from authors with a major training in electrical engineering. Most of the remaining authors had their basic training in physics and mathematics. It is probable that many of the physicists had elected electricity as their major interest in physics.

It follows that training in electricity is making a real contribution to the advancement of mechanics. The nature of the contribution will be brought out in this paper by illustrations taken in part from the author's own experience in the mechanics of structures. No illustrations will be given from other fields of mechanics, although it would not be difficult to find them.

TECHNIQUES OF MEASUREMENT

Force.—It is natural to put force first in a list of the fundamental mechanical quantities that must be measured. The classical means for measuring a force is to balance it with another force, as in the equal arm balance or in an unequal arm balance using the lever principle. An example for the latter is the beam and poise testing machine, which is still in wide use. Closely related to the mechanical lever is the "hydraulic lever" in which the forces are converted into pressures and levers of unequal length are replaced by pressure cells of unequal area. The hydraulic lever is used to measure the load in the large horizontal testing machine of 2,300,000-pounds capacity in compression of the National Bureau of Standards (*1*).[2] These mechanical systems have the virtue of simplicity in principle and of accuracy. Unfortunately they involve the displacement of masses with considerable inertia, so that it is impossible to measure forces that vary rapidly with time. The measurement of such forces requires that the measuring instrument should be either so stiff or so light that its lowest natural frequency is considerably higher than that of the highest frequency Fourier component in the force-time curve to be measured. This requirement is satisfied in any one of a series of electrical dynamometers in which the force causes an elastic strain proportional to it which, in turn, is measured by a wire strain gage attached to the dynamometer. The principle of the wire strain gage will be discussed below. The wire is so light and it is so securely attached to the dynamometer that it is able to follow even the most rapid strain variations in the dynamometer. The confidence in wire strain gages has at present grown to the point where they are used even for the weighing of aircraft and for the construction of precision dynamometers. Fig. 1 shows a Cox and Stevens weighing kit (*2*) consisting of three dynamometers of 50,000 pounds capacity, each of which may be placed on top of jacks supporting an airplane at three points. The load on each dynamometer passes through several vertical compression members on which wire strain gages are attached. The output of the wire strain gage on each dynamometer is read on a sensitive Wheatstone bridge. Weights may be determined with an error of less than 50 pounds in 50,000. Fig. 2 shows two experimental precision dynamometers, one of 1,000,000 pounds capacity and the other of 3,000,000 pounds capacity, being developed at the National Bureau of Standards to provide, for the first time, a means for calibrating testing machines for loads greater than 2,600,000 pounds. Each dynamometer is nothing more than a carefully machined steel cylinder to which eight wire strain gages have been attached longitudinally and circumferentially in a pattern which reduces errors caused by temperature variations and by eccentricity of the load on the dynamometer. Fig. 3 shows two less precise dynamometers built for special purposes. The first is a dynamometer of 15,000 pounds capacity for measuring the tension in a cable. It is simply a tension member with four wire strain gages attached in an axial direction. The second is a small experimental compression dynamometer of 80 pounds capacity for measuring rapidly varying forces transmitted through a very rigid

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[1] Address delivered on January 15, 1949, as retiring president of the Philosophical Society of Washington. Received April 11, 1949.

[2] Italic numbers in parentheses refer to the references at end of paper.

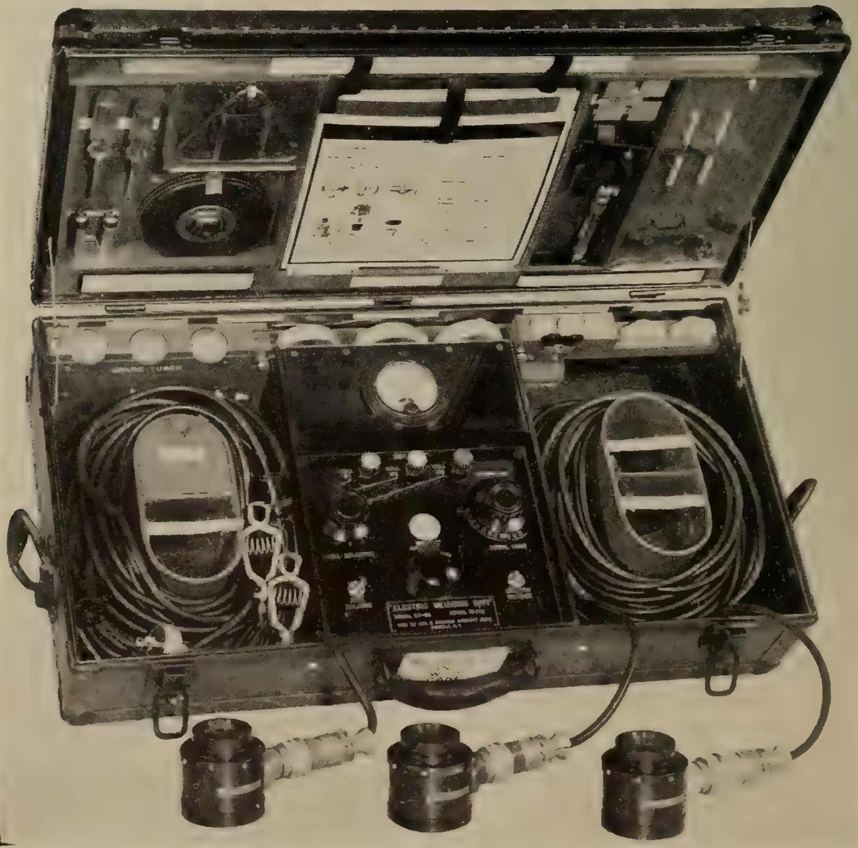

FIG. 1.—Cox and Stevens weighing kit containing three compression dynamometers of 50,000 pounds capacity each.

WALTER RAMBERG, President of the Philosophical Society of Washington, 1948.

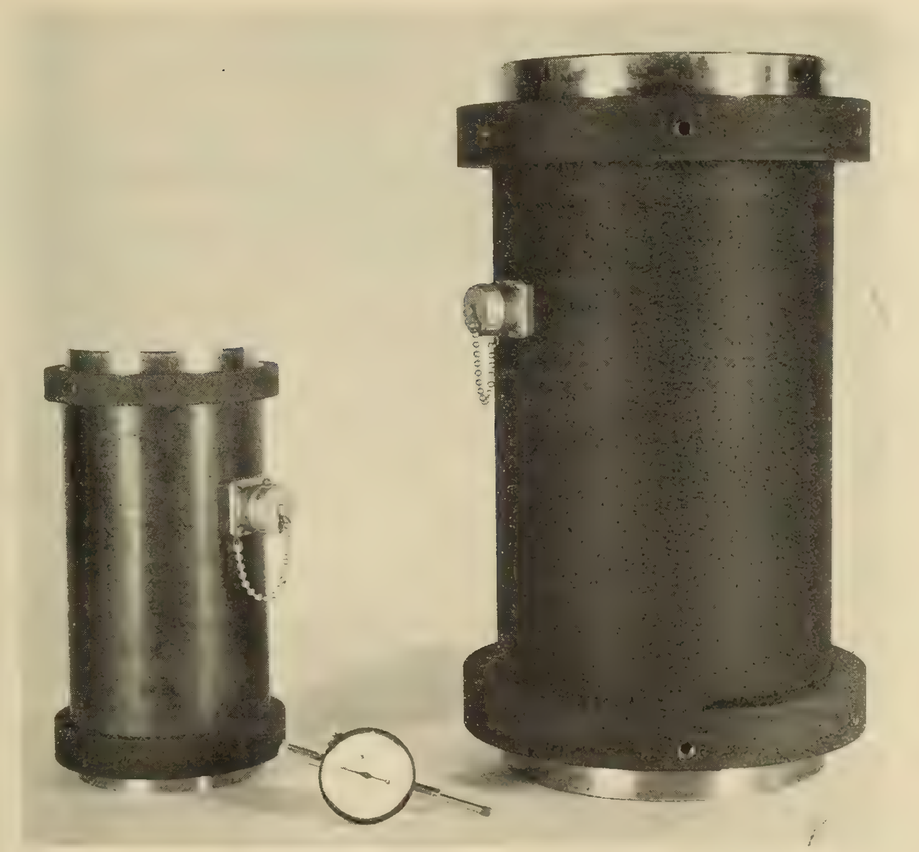

Fig. 2.—NBS experimental compression dynamometers of 1,000,000 and 3,000,000 pounds capacity.

structure such as a hardness testing machine. This dynamometer is interesting from the point of view of the theory of curved elastic membranes. The middle portion of the dynamometer has been machined down to a wall thickness of about 0.004 inch and has been pressed into a corrugation of double curvature with principle radii a, b where $2a$ is the average diameter of the dynamometer and b is the radius of the corrugation. It can be shown from the theory of curved elastic membranes (*3*) that the circumferential strain ϵ_c in the corrugation is given by

$$\epsilon_c = \frac{a}{b}\,\epsilon_a, \tag{1}$$

where ϵ_a is the axial strain corresponding to the external load. The axial strain is magnified in the ratio a/b according to the theory. A dynamometer of relatively large output and at the same time exceptional rigidity is therefore obtained by bonding a strain sensitive wire to the bottom of the corrugation. Tests of the dynamometer shown in Fig. 3 gave an output somewhat less than the theoretical output given by equation (1); this was ascribed to loss of strain in the bonding medium.

Pressure.—The classical ways of measuring pressure are by the difference in height of a column of liquid as in the mercury barometer or by the deflection of an elastic pressure capsule as in the Bourdon gage, in which the pressure tends to straighten a curved tube, which, in turn, causes rotation of a pointer. Electricity has suggested several other methods of measuring pressure. Extremely small and slowly varying pressures may be measured with the "vibrotron" (*4*) which uses an old principle in strain gage technique (*19*). In the vibrotron (Fig. 4) the pressure variations cause a change in tension in a wire stretched be-

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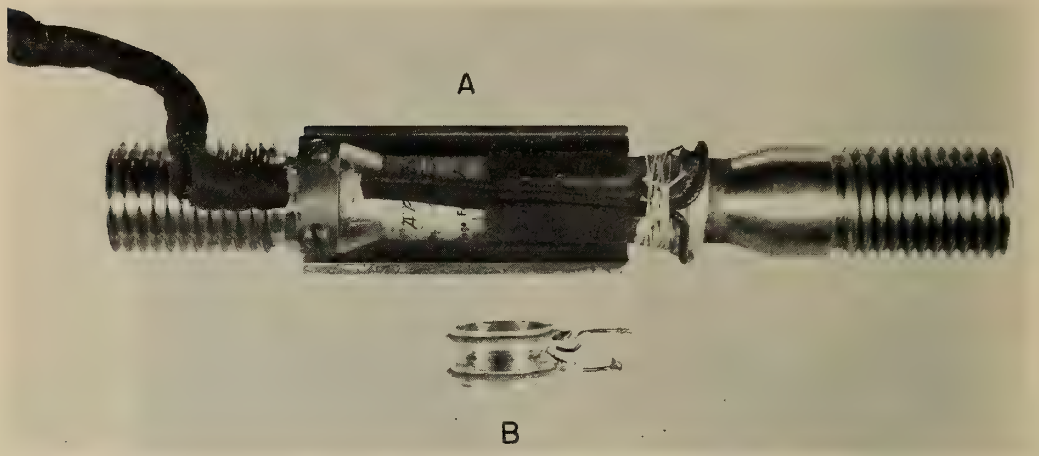

Fig. 3.—Special wire strain gage dynamometers: A, Tension dynamometer of 15,000 pounds capacity; B, compression dynamometer of 80 pounds capacity.

tween the poles of two or more magnets. The wire is vibrated in one of its natural modes of transverse vibration as a stretched string by connecting it into an oscillating electric circuit with feedback. The frequency of the mode will vary with the tension in the wire so that the changes in pressure cause a frequency modulation of the current in the oscillating circuit, which can be either recorded or transmitted to a distant receiver. Larger and more rapidly changing pressures may be measured electrically with the Statham pressure pickup in which the pressure causes an extension of a small bellows, which, in turn, strains an unbonded strain sensitive wire and causes its resistance to change in proportion to the pressure (*5*). Very rapid pressure changes may be measured electrically with piezo-electric gages, in which the pressure causes the appearance of electric charges of opposite sign on certain faces of a crystal of quartz or Rochelle salt. These charges may be converted into a change in voltage on a high impedance circuit and may be amplified and recorded. Gages of this nature have long been used for recording gas pressure in gun barrels and in engine cylinders (*6*).

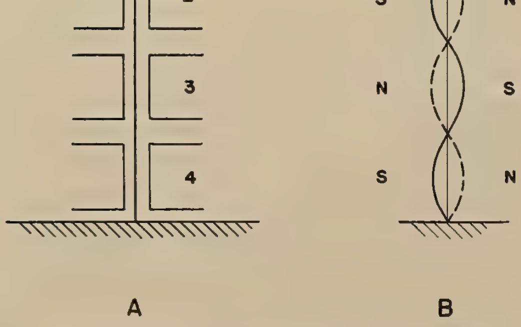

Fig. 4.—Vibrotron for barometric pressure measurements: A, Schematic diagram with wire strung between four magnets and attached to pressure bellows at top; B, mode of transverse vibration of wire with opposite field polarities on adjacent magnets.

Displacement.—Small displacements in structural mechanics are most commonly measured with dial gages in which a rack and pinion is used to convert displacement into rotation of a pointer. In this field, too, electrical methods are being used increasingly. Aleck, Goland, and Morris (*7*) developed a sensitive displacement gage in which the displacement causes strain in a ring which is picked up with wire strain gages again (Fig. 5). One of the most interesting electrical displacement gages utilizes the effect of displacing the core of a small transformer. The Baldwin Locomotive Works have embodied this principle in the design of their "microformer" replacing selsyn motors to transfer small displacements from points on a test specimen to a recorder

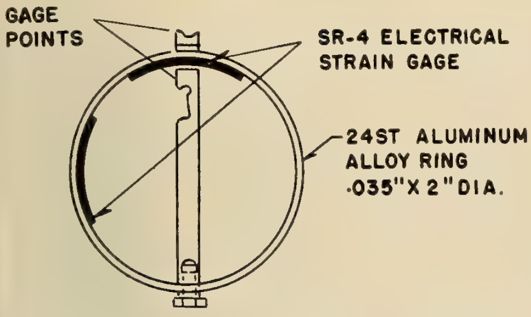
GAGE POINTS
SR-4 ELECTRICAL STRAIN GAGE
24ST ALUMINUM ALLOY RING .035"X 2"DIA.

Fig. 5.—Displacement gage of ring type (Aleck, Goland, and Morris).

(*8*). Schaevitz uses the same principle in somewhat different form in his "linear variable differential transformer" (*9*) in which a small magnetic core is pushed in and out of an insulating spool on which three coils of wire are wound coaxially (Fig. 6). A high frequency (1,000 c.p.s.) current is passed through the center coil. This sets up a magnetic flux linking the center coil with the two outer coils. The two outer coils are connected so that the voltages induced in them are balanced when the core is in the central position. As the core is displaced from this position an unbalance voltage is produced which is proportional to the displacement. The unbalance voltage is used to measure or record the displacement of the core. The gage is distinguished by linearity over a remarkably long range; it may be made linear for displacements of 1.5 inches with a sensitivity of about 0.001 inch.

The Statham unbonded wire pickup can be used for the measurement of displacement as well as pressure by simply replacing the coupling with the pressure sensitive bellows by contact to the structure on which displacement is to be measured.

Ross Gunn (*10*) has devised an ingenious and extremely sensitive displacement pickup, called the electronic micrometer. This pickup utilizes the effect of changing the relative spacing of electrodes in a vacuum tube. The vacuum tube contains two plates spaced symmetrically to either side of a fixed cathode. The plate supports are carried outside the tube through a flexible membrane in the envelope of the tube. They are brought to a point for making contact with the structure on which displacement is to be measured. The displacement causes one of the two plates to move toward the cathode and the other to move an equal distance away from the cathode. This results in an unbalance current in a Wheatstone bridge into which the plates and cathode are connected. The symmetrical construction of the plates and cathode in the tube makes the bridge insensitive to small variations in the supply voltage, since this will affect the currents to both plates equally. It is possible to detect displacements of less than 0.000001 inch with this pickup.

Strain.—Perhaps the greatest single contribution which electricity has made to mechanics during the past 10 years is the wire strain gage, which has already been mentioned above as a means of measuring mechanical quantities other than strain.

Before the advent of the wire strain gage strain measurements were made with any one of a great number of ingenious strain gages developed over the past hundred years. Most of these gages used the mechanical lever principle to magnify the extremely small displacements to be measured; examples of these are the Huggenberger (*11*)

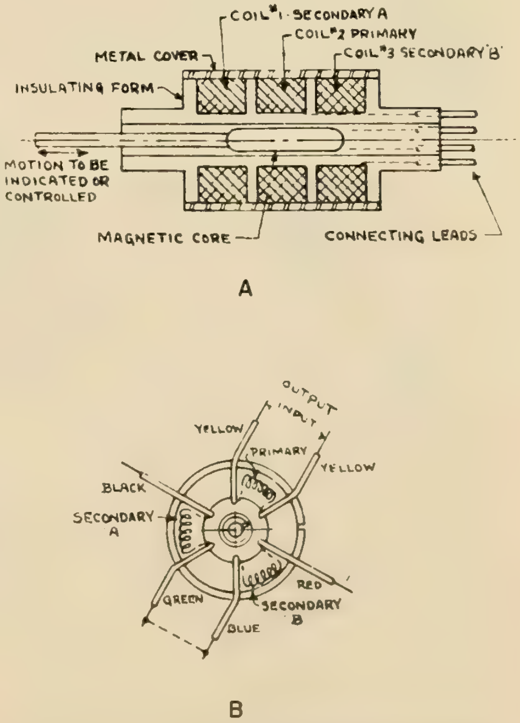

Fig. 6.—Linear variable transformer (Schaevitz): A, Cross section; B, end view showing connections.

and the Whittemore strain gages (*12*). Others use a combination of mechanical and optical lever, such as the Tuckerman optical strain gage (*13*), which is still a preferred instrument when a precision of better than 1 per cent is required. Unfortunately these gages are expensive; they are difficult to attach at remote locations and they will not follow rapid changes in strain. The wire strain gage has attained its popularity primarily because it is cheap, it is easily attached at inaccessible locations, and it will follow rapidly varying strain, and secondarily because convenient instruments have been developed which permit accurate measurements to be made by relatively inexperienced operators.

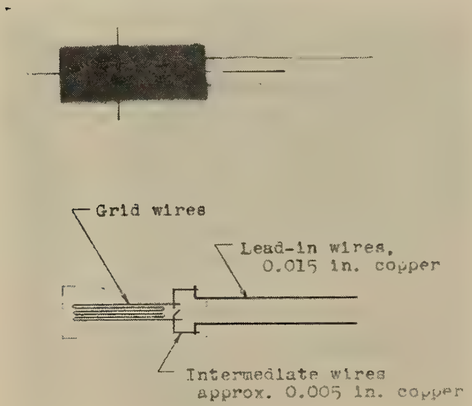
Grid wires
Lead-in wires, 0.015 in. copper
Intermediate wires approx. 0.005 in. copper

FIG. 7.—Wire strain gage.

The principle of the gage is very simple. A fine wire, usually 0.001 inch in diameter, is fastened to the structure in which strain is to be measured and it is strained along with the structure (Fig. 7). The strain changes the cross section and the length of the wire and along with it its resistance. The percentage change in resistance is usually about two times the strain, e.g., 0.02 per cent for a strain of 0.01 per cent, corresponding to a stress of 1,000 lb/in^2 in aluminum alloy or 3000 lb/in^2 in steel. This small change in resistance is measured commonly with a sensitive and stable Wheatstone bridge.

The wire strain gage has a unique history insofar as it is a purely American development. The development started with the well-known phenomenon, just outlined, that wire changes in resistance as it is strained, and it overcame the principal difficulty in utilizing this phenomenon for the measurement of strain, the difficulty that the wire will buckle when it is compressed. E. E. Simmons, of the California Institute of Technology (*14*), overcame this difficulty by bonding the wire to a piece of thin paper which was bonded to the structure in turn. The paper and bonding material transmit compressive as well as tensile strain from the structure to the wire without buckling the wire. Important contributions to the development of the wire strain gage were made at the same time by other workers in American laboratories, notably D. S. Clark and G. Daetwyler at the California Institute of Technology (*15*), Profs. A. C. Ruge and A. V. deForest at the Massachusetts Institute of Technology, and the engineers of several aircraft companies who developed wire strain gages for their own use. At present most of the gages are made by the Baldwin Locomotive Works under the trade name SR-4 strain gage. Over 250,000 of these gages are being sold per year.

Fifteen different types of gages, among them several of the SR-4 gages, were studied by W. R. Campbell at the National Bureau of Standards to determine their performance under various conditions of use. Such tests were urgently needed at the time to indicate which ones among these gages had the best performance in respect to uniformity, accuracy, linearity, sensitivity to transverse strain, sensitivity to temperature changes, etc. Uniformity is of particular importance since the wire strain gage cannot be calibrated either before or after use. The calibration constant must be determined on sample gages from the same batch, and it is then used on the assumption that the calibration of the sample gages applies to all the gages in the batch. The accuracy with which strain can be measured with an uncalibrated wire strain gage of the batch is, therefore, limited by the possible deviation of its calibration factor from that of the calibrated sample gages. This limitation does not apply to wire strain gages attached to pickups which are calibrated themselves. In that case the wire strain gages are calibrated indirectly in terms of the quantity measured by the pickup, e.g., force or dis-

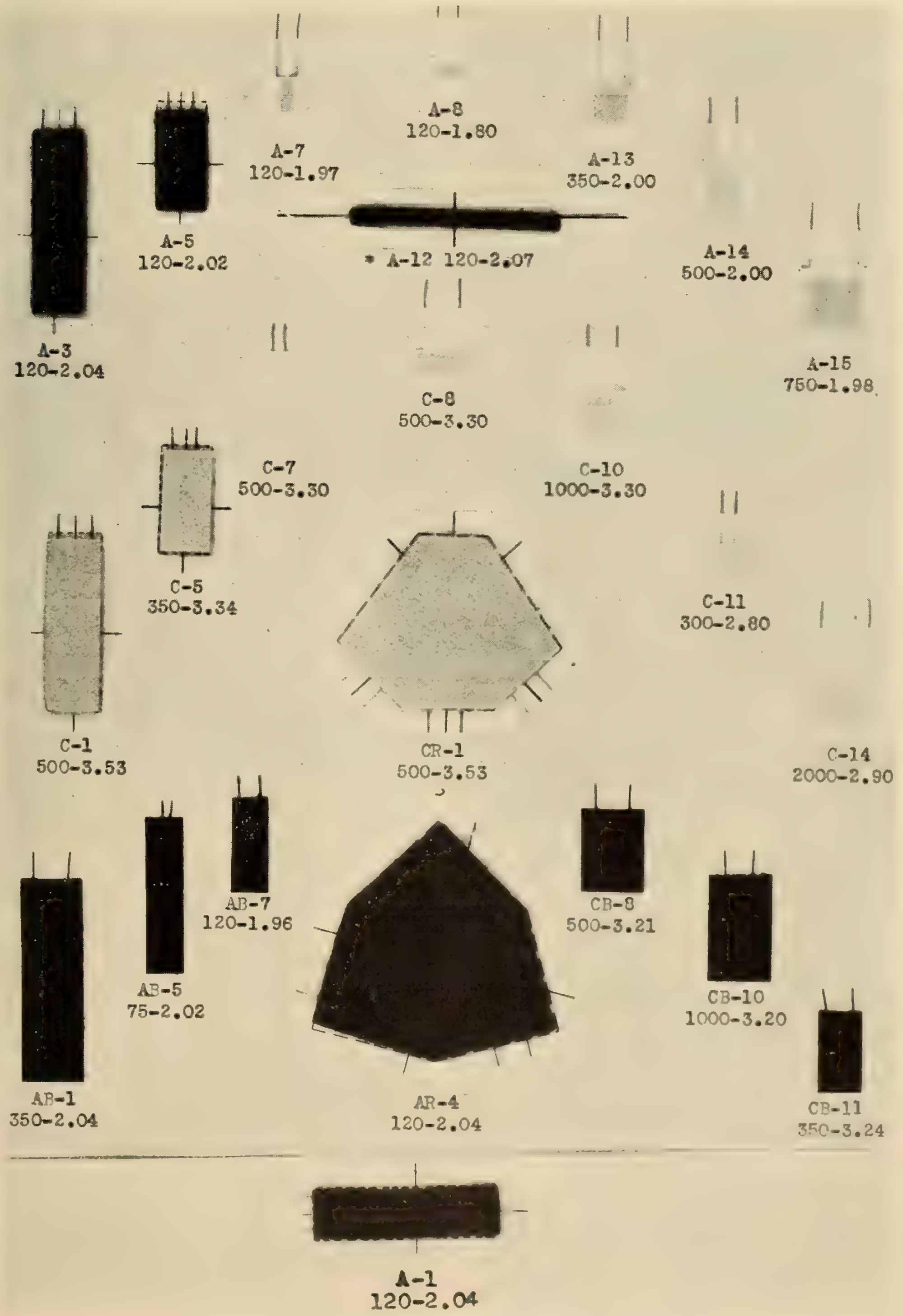

FIG. 8.—Commercially available types of wire strain gages. Legend below gages indicates SR-4 type number, resistance in ohms, and calibration factor.

placement, and the accuracy is limited only by the accuracy of the calibration procedure and the linearity and stability of the wire strain gages on the pickup. Accuracies of the order of ±0.1 per cent have been realized in some of the wire strain gage dynamometers already mentioned.

Wide variations in performance were found among the 15 types of gages tested (*16*). The gages of the better types, which incidentally included those in most common use at present, were found to indicate strains up to 0.002 accurately within about 1.5 per cent. The indicated strain is here taken as the strain computed from the measured change in resistance and the nominal values of calibration factor K furnished by the maker of the gage; the calibration factor is defined by

$$K = \frac{\Delta R/R}{\epsilon}, \tag{2}$$

where ΔR = change in resistance R of the gage caused by strain ϵ along the gage line.

For the better gages the calibration factors K were found to be the same in tension and in compression within 0.5 per cent and they differed by no more than 1 per cent for gages from a given batch.

Wire strain gages may be used for measuring much larger strains than 0.002, but the accuracy will drop by a factor of two or three. Recent unpublished developments hold out some hope that strains up to the breaking strain of the wire, over 20 per cent, may be measured with wire strain gages, if errors of the order of 5 per cent can be tolerated. This would extend the field of application of wire strain gages into that of plastic strain measurement.

The SR-4 wire strain gage is commercially available in a great many types. Some of these types are shown in Fig. 8. Gage lengths range from $\frac{1}{16}$ inch to 6 inches. Gage resistances range from 60 ohms to several thousand ohms. Some of the gages are wound around a piece of paper and are subsequently pressed flat. This makes the gage less sensitive to transverse strain than a gage wound in one plane, but it adds to its rigidity, thereby making it less suitable for measuring strain on thin sheet and more difficult to attach to a curved surface. Several materials are used for the strain sensitive wire; this leads to calibration factors K between 1.7 and 3.5. Most gages are wound with advance wire, which leads to a factor close to 2. The gages of the C series, Fig. 8, are wound with iso-elastic wire; this has a higher calibration factor than advance, but along with it has a higher thermal coefficient of resistance so that it is more susceptible to temperature variations; these gages are recommended for dynamic tests in which the higher temperature coefficient is not objectionable. Gage CR-1, Fig. 8, contains three separate wire strain gages mounted at an angle of 45° to each other in a so-called "rosette"; the readings along the three gage lines of the rosette are used to calculate the direction and magnitude of the principal strains on a flat surface.

Most of the SR-4 strain gages are attached with ordinary "Duco" household cement. This will give a satisfactory attachment at ordinary temperatures. Wire strain gages may be used at temperatures up to 300°F. if they are attached with bakelite cement. Six commercial bakelite bonded gages are shown with an AB and CB designation at the bottom of Fig. 8. By attachment with Sauereisen cement it has been possible to make wire strain gages which indicate strain at temperatures above 1,200°F. (*17*). Gages may be wound spirally to measure circumferential strain on a circular membrane. They may be wound in a herringbone pattern (*18*) to have a transverse sensitivity which is adjusted so that the change in resistance is proportional to stress rather than strain in the direction of the gage line. Gages may be wound with high resistance wire with a great many turns to give a resistance as high as 15,000 ohms. Such gages can be subjected to a relatively high voltage and they may be used for measuring strains on rotating members like propellers, where the signal must be passed through slip rings and brushes with unavoidable contact potentials.

There are other electrical means for measuring strain. The stretched wire principle of the "vibrotron" was used over 20 years ago in Russia (*19*) to provide an "acoustical strain gage." The change in spacing of condenser plates has been used (*20*). Strain gages have been built using the photoelectric effect. In one such strain gage, due to Gadd and Van Degrift (*21*), the strain causes relative motion of two gratings of alternate transparent and opaque bands, thereby changing the amount of light transmitted through the gratings. The variations in light are picked up with a photoelectric cell and recorder. The gage has a gage length of $\frac{1}{16}$ inch and an over-all magnification of 30,000.

Acceleration.—The measurement of acceleration was in a primitive state before the use of electrical methods. The commonest procedure was to trace the displacement of the accelerated body as a function of time and differentiate the displacement twice in respect to time. This brought with it the magnification of errors that is familiar to anyone who has tried graphical differentiation. Another method is to suspend a mass from a spring and scratch the displacement of that mass relative to the accelerated body with a stylus on a rotating drum. This method suffers from the tendency of the spring-supported mass to vibrate as a seismometer in response to high frequency vibration, and the inability of the mass to follow rapidly changing accelerations.

It has not been possible even with electrical methods to build accelerometers that cover all needs. However, the frequency range and accuracy have been greatly extended by using several of the electrical pickups already described above.

The unbonded wire in the Statham pressure pickup was first used by the Statham laboratories for designing acceleration pickups ranging from a capacity of 1.2 g at a natural frequency of 70 c.p.s. to a capacity of 200 g at a natural frequency of 1,400 c.p.s. (Fig. 9). The wire W is made sensitive to acceleration rather than pressure by attaching it to a mass M instead of a bellows. The mass is guided so that it will stress the wire by an amount proportional to the component of acceleration parallel to the wire. The piezo-electric pressure pickup can be converted in the same manner to a high frequency acceleration pickup.

The effect of relative displacement of electrodes in a vacuum tube, already utilized by Gunn for measuring displacement, was utilized at the National Bureau of Standards for measuring accelerations (*22*). For this purpose the supports of the plates P, Fig. 9, to either side of the fixed cathode C were made flexible rather than rigid, and they were designed so that the deflection of the plates relative to the cathode would be proportional to the component of acceleration normal to the plates. Vacuum tube accelerometers have been built both here and in England with natural frequencies ranging from 700 to 1,200 c.p.s. and capacities up to 150 g.

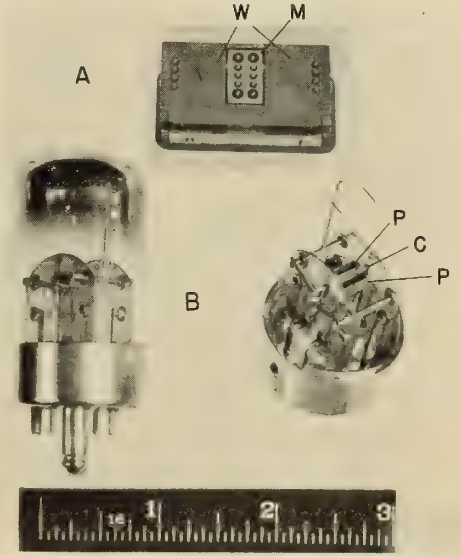

Fig. 9.—Electric acceleration pickups: A, Statham acceleration pickup, capacity 12 g; B, NBS vacuum-tube acceleration pickup, capacity 150 g.

Applicability of electrical pickups to measurement of several mechanical quantities.—The preceding description of electrical pickups for measuring mechanical quantities, though very incomplete, brings out not only the variety of pickups, but also the fact that any given type of pickup can be used for the measurement of more than one mechanical quantity.

A comprehensive paper describing electrical techniques for measuring mechanical quantities might well be arranged by type of pickup rather than type of mechanical measurement. Any good displacement pickup, for instance, can be used for measuring force, since force will cause displacement in an elastic dynamometer. It can be used for measuring pressure, which causes displacement of a bellows. It can be used for measuring strain, which results in relative displacement over a finite gage length. It can be used for measuring acceleration of a spring supported mass. Any good linear pickup will thus have at once an extensive field of application in mechanics.

TESTING TECHNIQUES

Electricity has made a major contribution also to the techniques of mechanical testing of structures, particularly the testing under dynamic loads.

Vibrators.—Nearly all vibrators for maintaining elastic structures in a steady state of resonant vibration are electrical. Fig. 10 shows an electrodynamic vibrator of a type which is coming into increasing use to excite normal modes in aircraft. The "push-pull" motor of the vibrator consists of a coil similar to the voice coil in a loud speaker. The coil is placed in a strong magnetic field and it is driven by passing alternating current through it. The particular vibrator shown in the figure is among the earliest and largest of its kind. It is one of a pair built by the Goodyear Zeppelin Corporation over ten years ago to make fatigue tests of wing beams at the National Bureau of Standards (*23*). Each vibrator has a capacity of 1,250 watts at 60 c.p.s.

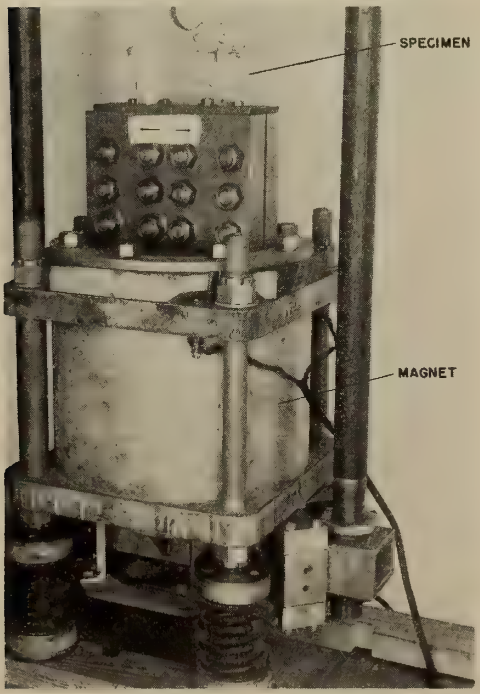

Fig. 10.—Electrodynamic vibrator of push-pull type; output 1,250 watts at 60 c.p.s.

Dynamic recording.—Electricity has revolutionized the recording of mechanical quantities, particularly during a dynamic test. The output of most electrical pickups used in such a test is so small that it requires amplification before it is fed into a string galvanometer or cathode ray oscillograph. Fig. 11 shows a 6-channel recording equipment which is in constant use at the National Bureau of Standards. This equipment will take the output from four wire strain gages into four Wheatstone bridges fed by 1,000-cycle alternating current. Each one of the four bridges is supplied with separate controls for balancing the resistive and reactive component of the voltage. The unbalanced voltage is then amplified to the desired level, passed through a band pass filter with flat response up to 100 c.p.s. to remove hash, rectified, and fed into four of the six galvanometers in a 6-channel recorder. The remaining two channels of the recorder can be utilized for timing and for recording from a pickup with high output, not requiring amplification, such as the vacuum-tube accelerometer.

It is not surprising after an examination of this recording equipment that electronics engineers are as important in dynamic tests of structures as mechanical engineers and that the cost of electrical equipment frequently outweighs that of the mechanical equipment. The cost of the recorder for one wire strain gage is approximately 1,000 times that of the gage itself.

ANALYSIS

Electricity has led the way in the analysis of many important problems in the mechanics of structures.

Electrical analogues.—The equations for the flow of current in certain electrical conductors under given differences of potential are identical mathematically with the equations for the velocities of points in an analogous mechanical structure under given external forces.

Den Hartog showed, for example (*24*), that the performance of the damped vibration absorber of Fig. 12 could be derived

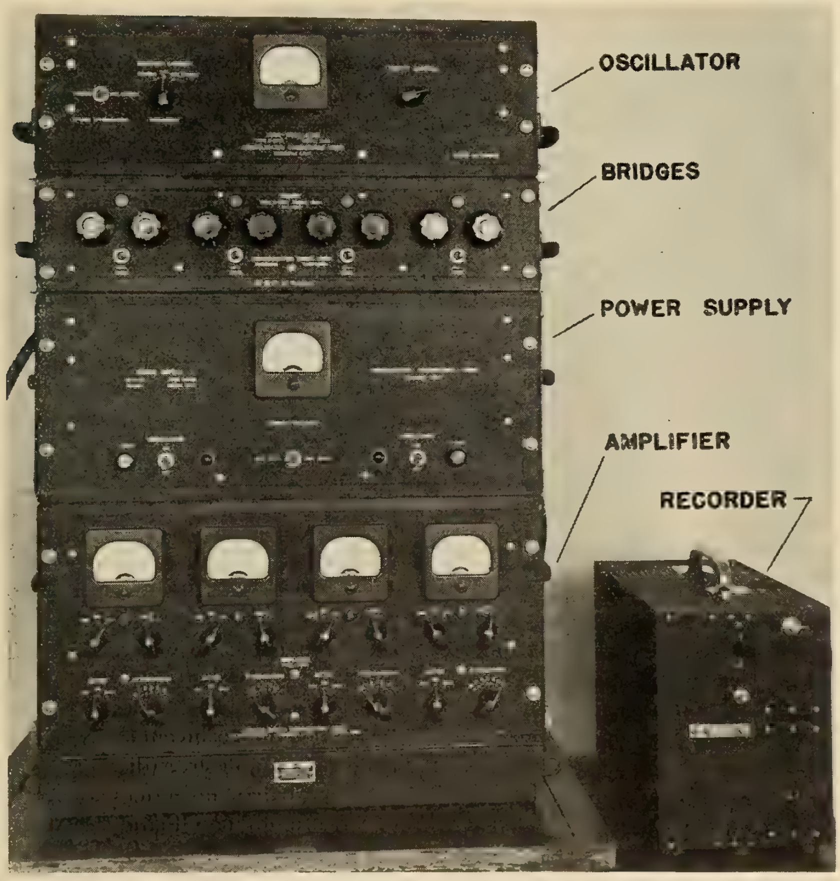

Fig. 11.—Multichannel recording equipment.

from the impedance of the analogous electrical circuit of Fig. 13. This impedance is readily obtained in terms of complex numbers by methods familiar to electrical engineers.

The electrical analogue is useful also for an experimental analysis of the effect of changes in mass distribution, stiffness, and frequency of applied alternating forces on the stresses set up in the members of a structure such as a railroad bridge traversed by a locomotive. It is much easier to change the inductances, capacities, and the frequency of the applied voltage in the analogous electrical circuit than to change the corresponding mechanical parameters of the bridge. V. Bush (*25*) estimates that a structural analysis may be made on the electric analogue of a railroad bridge with an uncertainty of only 3 per cent in the stresses determined from the voltages at various points on the electric circuit.

Analysis of transients.—Electricity has pointed the way to the rational analysis of transients in mechanical systems. Mechanical transients have become an urgent problem in aircraft during the last few years. The problem arose with the occurrence of failures in the wing and tail structure of large transport airplanes under apparently normal landing conditions. The stresses computed corresponding to these landing conditions, on the usual assumption that the airplane was decelerated as a rigid body, were far below those required to explain failure. The "rigid body" analysis was obviously inadequate for designing against landing impact. A more refined analysis was necessary to determine the transient elastic deflections of the airplane structure in response to the landing impact. The response in each mode of vibration of the airplane structure (*26*) can be found readily from Duhamel's integral

$$q_i\ (t) = \frac{1}{M_i\ \omega_i}\int_0^t Q_i\ (\tau)\ sin\ \omega_i\ (t-\tau)\ d\tau \qquad (3)$$

where $q_i(t)$ is the deflection in the i-th mode, of frequency ω_i, of an equivalent linear oscillator of mass M_i, deflected by an external force $Q_i(t)$. The transients measured during landing tests of a model wing (*27*) were found to be in agreement with those computed by superimposing the responses q_1, q_2, q_3 for the first three modes of vibration.

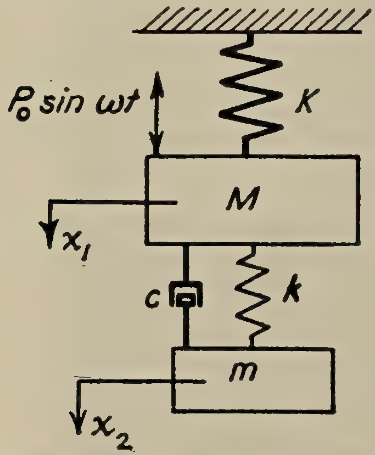

FIG. 12.—Damped vibration absorber of mass *m*, spring *k*, and damping *c* attached to undamped machine of mass *m* on spring *k*, subjected to an alternating force P_o sin ω *t*.

Duhamel's integral is a special case of Heaviside's famous superposition integral for determining the transients in electrical networks. The mechanical engineers concerned with the analysis of the problem of landing impact are finding that Heaviside and his disciples in the development of the operational calculus have already pointed out short cuts to solutions of some of their problems. Mechanical engineers are forced to think of their structures as mechanical circuits with impedance and admittance.

Electrical computers.—Electricity is making a great contribution to mechanics in speeding computation.

There was a marked increase in speed of computation when the hand-driven crank of the computing machine was replaced by an electric motor. A further increase was realized with a reduction in mass of the moving parts and later with the replacement of mechanical counters by relays of the type used in telephone exchanges. The range of application of computers was at the same time greatly increased with the introduction of punched cards for the storage of data and for use as an input medium in place of the human operator. By these means it was possible to transform a great variety of computations to a purely automatic procedure; however, the speed of computation was limited by the inertia of the moving parts of the machine. The next great advance was made with the development of the electronic computer which utilizes electrons, with their negligible mass, to carry out the operation of addition and subtraction and with them those of multiplication and division. Such an electronic computer is the ENIAC (Electronic Numerical Integrator And Calculator) developed at the Moore School of Engineering of the University of Pennsylvania, and now in operation at the Aberdeen Proving Ground. The basic unit of electronic computers (*28*) is a circuit familiar to radio engineers as the Eccles-Jordan trigger circuit or multivibrator. The trigger circuit is an electronic relay consisting of a pair of vacuum tubes which are connected so that at any time one and only one of the pair can be conducting. The trigger can be reversed, that is, the other triode can be made conducting in less than one-millionth of a second. Ten triggers are used in the ENIAC to transmit any digit between 0 and 9. It is not surprising, therefore, that the ENIAC uses 18,000 vacuum tubes to handle 9-place

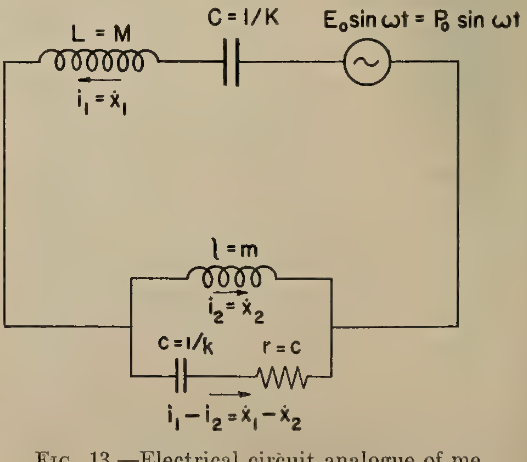

FIG. 13.—Electrical circuit analogue of mechanical system of Fig. 12.

numbers. However, thanks to the small reaction time of these tubes it is possible to multiply two 9-place numbers in less than 0.003 second as compared to about 15 seconds with a conventional computing machine.

The electronic computer is so rapid that the temporary storage of information between cycles and before transcription becomes a major problem. Several ingenious schemes have been devised to accumulate information including registration on a magnetic tape and temporary retention in the form of sound waves passing repeatedly through a column of mercury. An adequate description of these schemes would go beyond the scope of this paper as well as beyond the competence of the author.

The principal point to note is that the automatic-sequence computer steps in to overcome the barrier of human fatigue involved in carrying out thousands and thousands of routine operations. It has stepped in so effectively that several aircraft companies have installed large scale computers for their own flutter computations. Ballistic laboratories are supporting the development of computers because among other things they can obtain an answer to a ballistic problem between successive firings of a gun. The National Bureau of Standards is coordinating the development of automatic sequence electronic computers for several Government agencies, among them the Bureau of the Census, the Office of Naval Research, and the U. S. Air Forces. Automatic-sequence computers will find many new uses in the solution of mechanical problems as methods are mastered for reducing the solution of these problems to routine numerical procedures of a type that can be handled by the computer.

CONCLUSION

We cannot help being impressed by the great and growing contribution of electricity to mechanics. Electricity has accumulated a credit which mechanics can probably never pay off, since there is little chance that mechanics will discover an agent as nimble, as controllable, and as universal as the electron for carrying out tasks that seemed impossible before. A similar story of indebtedness to electricity can be told about the other fields of engineering. It is really part and parcel of the essential unity of all scientific knowledge. All branches of science must stay in debt to each other in order to advance to their greatest potentialities. It is not unreasonable to hope that some future "Past-President" of this Society may give another illustration of this essential unity of science by talking on the contributions of mechanics to electricity.

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ETHNOLOGY.—*The animal that cannot lie down.*[1] Horace P. Beck, Temple University. (Communicated by W. N. Fenton.)

This paper has a twofold purpose—to suggest the possibility of native origin for more of our American folklore than is generally accepted and to indicate evidence of man in North America in late Pleistocene times through fossilized legends. To these ends the old theme of the stiff-legged elephant will be treated with the idea, not that one swallow makes a summer, but rather that one story may, if closely followed, indicate further possibilities. This story, because of its many peculiar aspects, has been discussed widely among folklorists in this country. Let us, in order to get a rounded picture of the problem, look first to Europe and trace, in a general way, the history of the Creature-Who-Could-Not-Lie-Down.

About 350 B.C., to give our tale some antiquity, Aristotle remarked, "What is asserted of the elephant by some is not true (i.e., he cannot bend his legs nor sit) for he can do both, except that he cannot, on account of his weight, at one and the same time bend each fore leg, but he can alone bend one leg and recline on one side, and in that manner he sleeps (leaning against some wall or tree)."[2]

Leaping a millennium, we come to the Anglo-Saxon and his poems of the Whale, the Panther, and the Partridge. Since these stories parallel the Middle English Bestiary, it is usually believed that they are the vestigial remains of an Anglo-Saxon Bestiary, long since lost to us. If that be the case, the Anglo-Saxons must have been acquainted with this elephant story, since it appears in the Middle English Bestiary. Here, the tale of Aristotle has gained color:

In Ynde ye may Elephants see
Big and burly in body they be

……

One thing they have most in thought,
That they ne'er to a fall be brought
Since they be lacking the power
To rise again in that hour.

……

He doth seek to himself a tree,

……

And against the trunk doth lean,
When weary with walking I ween.
When the hunter this doth know.

……

Seeing where the beast doth go
This his rest to get
Then the tree doth he saw away

……

His work with care doth hide.

……

Then cometh the monster I ween
On his side 'gainst the tree doth lean.
In the shade of the tree so tall,
Doth he sleep, and together they fall.[3]

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[1] Received March 31, 1949.

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So far this story fits a pleasant pattern. Scholars, during Middle English times, were interested in Greek literature, in Latin translation, and took what they found there for fact. Seeing the story about the elephant, they believed it, embroidered it, gave it a religious twist, and handed it out for gospel. Unfortunately, there is a flaw in the picture.

When Caesar went to Gaul, he recounted in the sixth book, Chapter XXVII, of his Commentaries, the following small anecdote:

> There are also animals that are called elks. The shape of these, and the varied color of their skins, are much like does, but in size they surpass them a little and are destitute of horns, and have legs without joints and ligatures; nor do they lie down for the purpose of rest, nor, if they have been thrown down by any accident can they raise or lift themselves up. Trees serve as beds to them; they lean themselves against them, and thus reclining only slightly they take their rest. When the huntsmen have discovered . . . whither they are accustomed to betake themselves they either undermine all the trees at the roots or cut into them so far that the upper part of the trees may appear to be left standing. When they have leant upon them,—they knock down by their weight the unsupported trees, and fall down themselves among them.

These Gallic people had never heard of Aristotle, nor could they read Greek, yet they had a story identical to Aristotle's except that it referred to a different animal. The writers of The Bestiary, remembering this legend from their own past simply adopted Aristotle's version, as an improvement on their own myth, gave it a religious twist and handed it out anew—common practice among the folk.

Since elephants did not inhabit Greece, it is safe to say that Aristotle picked up the story from people who lived with elephants and believed it because there was a similar belief in Greece. Thus we have the story in two, and possibly three, widely separated regions—India,[4] Europe, and the Near East. It looks universal.

If this is true, then we should expect to find the tale in China and Siberia. There are legends concerning the creature in both these regions, but they are of the *ipso facto* variety rather than any real memory of a living monster. This type of myth we will discuss later.

We know that at the time of the coming of the whites to this country this fable was popular in England. It was well enough known that Shakespeare, writing for the masses, devotes a line of *Troilus and Cressida* (Act I, Scene 2) to the myth. "Ulysses: 'The elephant hath joints, but none for courtesy'." As late as 1646 Sir Thomas Browne felt that this belief was prevalent enough in the minds of his fellow countrymen to be exposed and he therefore devoted a substantial portion of his *Vulgar errors* to the theme "That an elephant hath no joints." Therefore, is it not possible that the English told this story to the Indians, who retained and repeated it to the present day?

It is true that many European folk tales were told the Indian. However, when the language barriers and all the attendant difficulties of the time are considered, it does not seem probable that such an involved story would be told in the early days of the first contact. Later this would be possible, but by the end of the seventeenth century the idea of jointless animals was practically dead. Further, it is not likely that the Indian would accept a story the ideas of which were completely unknown to him. It is not usually the case with the folk. They will adopt things they can understand or have already in their culture, but usually the adoption is, like the Bestiary, an embroidery. This immediately raises the question of Lady Godiva, knights in armor, castles, and fairies—obviously European folk tales. What about them? One need only read the early accounts of the Jesuits and explorers like Cabesa Da Vaca and Cartier to discover that the Indian had tales similar to these white stories—The Seven Cities Of Cibola, The Spring Of Life, and The Land Of Headless Men are but a sample of the host of stories in this vein.

Let us now examine Indian tales relating to this Creature-Who-Cannot-Lie-Down and then attempt to put it into the idea of a fossilized memory of the mammoth.

F. G. Speck records from the Penobscot in Maine the story of White Owl and His Escape From the Witches and Great Beasts. The myth has several stories woven into it, but the one about the great beast predominates.

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[4] For a further discussion of the possibilities of the mammoth being known in India, see Falconer, *Paleontological memoirs:* 375. London, 1868, wherein there is an account of the elephant-tortoise myth linking it to prehistoric times.

A culture-hero called White Owl, while traveling to the south, discovers some moving hillocks covered with brown vegetation. Upon closer observation he finds that in reality the hillocks are great long-toothed beasts who could drink for half a day and were so huge that they could not get up if they lay down. Deciding, in a leisure moment, to kill them he found out where the animals went at night and observed that they slept leaning against trees. Accordingly he cut the trees part way through, and when the creatures leaned against them both tree and animal fell to earth. Since the fallen animals were unable to rise again, Snowy Owl proceeded to shoot them with his magic arrows.[5]

From Labrador, both Dr. Speck and Dr. Strong record versions of this story. In this case the beast is called Katci-to-wushk, "Stiff-Legged Bear." The story begins when Katci-to-wushk kills a man and a woman but leaves behind a newborn baby who is reared by his sister until he goes out to seek his parents' murderer. "He found large round deep tracks in the snow which he followed . . . Katci-to-wushk came and found Djakabish in his track and hit him with his long nose and knocked him down. Djakabish shot him in both hips. The monster said, 'eat my head but keep my ears for your bed'."[6]

Later the head became rejuvenated and set out after Djakabish, who heard its great teeth rattling and was warned in time to kill it.

Although these are all modern accounts and localized to the Northeast, the distribution of the myth is widespread and has been recounted by the early writers of the eighteenth and nineteenth century. Charlevoix remarks in 1744, "There appears to be among the barbarians a pleasant story of a great moose who makes all other moose look like ants. Its legs, they say, are so high that eight feet of snow does not bother them; its hide is so thick that no kind of weapon can penetrate it, and it has a sort of arm which protrudes from between its shoulders and is used as we use ours."[7]

A southern writer, early in the period of colonization, remarked that the moss growing on the trees is the regeneration of the hair of a great beast that roamed through the forest and had its hair torn out by the tree limbs.

James Kenny reports in 1761, "Strange Indians from beyond the Mississippi said 'that their country has many very large horses in it which never lyes down to sleep but leans against a tree for that purpose.' "[8]

One of the more interesting legends of the eighteen century and one that would bear a little discussion is one recorded by Dr. Samuel Mitchill in 1795 and was purported, by him, to relate to the exploits of the famous, but questionably mortal, Delaware Chief, Tammany. Among other typically "culture hero deeds" surrounding him Mitchill says:

> Frustrated in this scheme, (to destroy Tammany) he (the evil spirit of the North) brought from the side of Lake Superior, alarming droves of MAMMOTHS, carnivorous animals, and especially loving to feed upon human flesh. These he turned loose upon the Tammanial Territories, and many deaths and much devastation they caused. They were so swift that nobody could overtake them, and so ferocious that they filled whole villages with terror. Arrows fell blunted from their skins and clubs assailed them in vain. From some prisoners brought home in an expedition against the Indians of the Tide-Waters, the Tammanites had learned the use of seasoning for their food, and a part of the tribute paid to their conquerors by the Atlantic Nation, was dried fish and salt. This latter they caused to be brought thither in vast quantities, and the creatures of the wilderness, attracted by the diffusion of its atoms thro' the air, flocked around the magazines, and pawed and licked the dust impregnated with the smallest saline particles. They grew so fond of it that Tammany ordered large spots of ground to be sprinkled with salt that the wild animals drawn thither might fall a more easy prey to the hunters, who laid in wait to kill them. Among others came the mammoth, who was remarkably ravenous of the product of the ocean, and when intent in gratifying his palate, was led into the covered pits dug across his paths by the direction of Tammany, and there expired impaled on the sharpened points of trees which tore to pieces his belly and bowels as he fell. Thus the country was cleared of those monsters, whose bones discovered

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[5] Speck, F. G., *One of Caesar's anecdotes among the Indians of eastern North America.* Alumni Register Univ. Pennsylvania **19** (9): 686–690. 1917.

[6] Strong, W. D., *North American Indian traditions suggesting a knowledge of the mammoth.* Amer. Anthrop. **36**: 83, 84. 1934.

[7] Charlevoix, Pierre F. X. de, *Journal d'un voyage fait par ordre du roi dans l'Amerique septentrionale* **5**: 185. Paris, 1744.

[8] Masterson, J. R., *Travelers' tales of Colonial natural history.* Journ. Amer. Folklore **59**: 55. 1946.

to this day at the Licks, confirm the reality of the story.[9]

This anecdote bears some discussion, especially when we remember that Washington Irving took umbrage at Dr. Mitchill and spent some little time discrediting him. In the first place, we know that Tammany, if he did live, existed, in all probability, in the seventeenth century—well past the day of mammoths. Still, it would be possible, presumably, to have old legends collect around a relatively modern epic hero. In fact, that is usually the case. However, we may be certain that the term "mammoth" is the mouthing, not of the Delaware, but of Dr. Mitchill. It would stretch a point indeed to believe that North American Indians used a Russian word to describe a prehistoric elephant. Other writers refer to this creature as an elk, great beast, horse, bear, and so on and then list its properties.

Next we come to the idea that the mammoth was carnivorous. True, other accounts describe the animal as man-eating, but Mitchill's use of the word, coupled with the fact that William Hunter as early as 1741 had erroneously believed the mammoth to be carnivorous through an examination of its teeth, leads us to suspect that the worthy Dr. Mitchill was to some extent drawing upon written sources. This is further emphasized when he uses the "present day" finds of bones near Salt Licks which further reenforced the idea that the tale was, as we might say, *ipso facto*.

Another feature, and perhaps the most interesting one of all, is to be found in the manner in which these creatures were taken. It is true that certain tribes in the Northeast did employ pitfalls until a fairly recent date. In fact, one may see depressions in the woods of Nova Scotia today that the Micmac claim were placed in moose paths to catch that animal. But the stake pitfall is another matter. We know that they existed in the Northwest and Southwest. They also existed in Africa. Whether they ever existed in the Northeast can not, of course, be determined. This author, in an extended survey of traps has, as yet, found no reference to any such taking device. This brings up the question as to whether Dr. Mitchill obtained his details from an Indian or from a Negro slave. If he obtained it from an Indian, the reference must stand as an unique and extremely early one from this region.

In summary, we may conclude that the better part of this story is of continental or foreign origin. Still, the other legends surrounding Tammany, that Mitchill sets down, have an authentic ring and are told plausibly, such as How Tammany Got Tobacco, Chained the Wind, etc. It is also easier to improve a story than it is to fabricate one. Therefore it is safe to believe that at least part of this tale did exist among the Delawares at one time and that Dr. Mitchill merely improved upon it. Thus we find the story of The Great Beast in still another locality and among a people recognized as ancient among the other tribes of the Northeast and called by them Lénni Lenape.

Still another tale, not unlike Mitchill's, comes from the Tuscarora. Unfortunately the date is late, and Hewitt, like Mitchill, uses terms throughout the tale that could not, logically, be ascribed to the Indians. Like so many of the Six Nations peoples' tales, this one is full of foreign influence and highly developed as a literary masterpiece. Still, it gives one food for thought and aids in piling up material concerning the mammoth memory on this continent. The pertinent part of the longer tale is as follows:

> There was once an orphan boy who grew up among strangers and so fared very poorly but he grew to be a man of more than ordinary strength and agility. He was gifted also as an enchanter, an expert in the craft of the wizard. When he became of mature judgment he asked the oldest and most experienced man among his people if there was a place where man could not go, and he was told that to the Southward there must be something that was supernatural and monstrous for none of those who had gone far in that direction ever returned. So the orphan started off in that forbidding direction. After he had traveled three days and had just crossed a river by walking on the water, he was astonished to see U-ya-kwa-her following closely a bear and quickly to overtake and kill it with one blow of its trunk, and to see it rapidly retrace its steps and soon burst forth from the thickets a lion closely pursued by U-ya-kwa-her which with a few strides overtook and killed the lion with one blow of his trunk, crushing the heads of both but not

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[9] MITCHILL, SAMUEL, *The life, exploits and precepts of Tammany: Read in the Old Presbyterian Church in the City of New York on Tuesday, the Twelfth of May, 1795:* 7–8. New York, 1795.

attempting to eat either as U-ya-kwa-her did not eat flesh. But now the orphan saw that U-ya-kwa-her would then perceive his presence and follow to destroy him, so he ran a short distance and climbed a large tree, and before he had climbed up very far he saw that U-ya-kwa-her was pursuing him; it soon came up to the tree and without looking upward which power it had not, it began digging around and thus to uproot the tree. Before long the tree began to topple and the orphan was ready to run down the tree to its base, for when the tree commenced to fall U-ya-kwa-her ran towards the place where the tree would fall in order to find its supposed victim dead among the branches and by the time U-ya-kwa-her found the orphan's tracks on the top of the tree the orphan was quite a long way up another tree, and U-ya-kwa-her would follow him thither and immediately begin digging up the tree and so soon as it would begin to fall U-ya-kwa-her would immediately run to the place where the tree would fall and that would enable the orphan to run down the tree as it became sufficiently inclined to enable him to do so, and U-ya-kwa-her would be looking for him among the branches of the tree top. Thus it dug down many trees. Finally he managed to go from one tree top to another and so a second and a third time so that when the tree he climbed fell the U-ya-kwa-her was not able to find his tracks. So the monster began immediately to go in a circle around the tree until the circle became so large that on one side it reached the river where the orphan had crossed walking on the water so he saw that he could make his way to the river without having to cross the last circle long before the beast would be back and his tracks would be hidden by the waves. So the orphan came down the tree and made his way down to the river re-crossed it as he had by walking on the water. He made his way home where he related what had befallen those that had gone there but never returned for he saw their bones lying in many places the victims of the monster that had chased him so unsuccessfully.[10]

David Thompson, writing the Narration of his exploration, 1784–1812, edited by J. B. Tyrrell in 1916, mentioned the fact that the Athapaskans told him there was a tundra animal that much resembled the mammoth.

Today, there is a legend among the Chitimacha: "A long time ago, a being with a long nose came out of the ocean and began to kill people. It would root up trees with its nose to get at people in the branches."[11] And among the Indians of Massachusetts there is a myth about animated "haystacks" that walked along the beach at Marthas Vineyard.

These are but a few of a host of stories and tales, both past and present, concerning this creature. They cover the length and breadth of North America, and all of them seem to be rough descriptions of some creature with the following characteristics: Huge size; terrible, long teeth (in one instance, at least, curved spears long enough to impale seven men); huge ears; tough hide; ferocious disposition; shaggy brown hair; and inclined to drink great quantities of water. To kill it was a feat for a culture-hero of the stoutest mettle. There seems little doubt that such a description fits, of all things, the elephant or mammoth.

Until recently, there was no conclusive proof that man and mammoth were ever in contact with each other on this continent.[12] However, through excavation, archeologists were finally able to link him with an extinct species of huge bison and an extinct sloth, and in 1936 a gravel pit was opened at Clovis, N. Mex. Here were found mammoth bones and, under the bones, Folsom points. J. L. Cotter completes his report with, "The contemporaneity of deposition of these artifacts cannot be doubted."[13] In other words, man and mammoth were associated at one time on this continent.

Of course, it can be argued that if this were a story based on fact, then if we could show the Indians the remains of a mammoth they would recognize it as the beast of their stories. Unfortunately this has not proved to be the case. Natives of the Parma River when shown the skeletal remains of a mammoth expressed the opinion that they were the bones of a giant burrowing rabbit whose smaller kinfolk still abound in the region.[14] According to Ezra Stiles, when the skeletal remains of a mammoth were exhumed in Connecticut in the eighteenth century, Indians remarked, "You would not believe us when we told you the devil was killed here." However, this is hardly surprising. Skeletal remains do not resemble the living creature, and it is fairly probable that they would not have recognized the whole carcass.

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[10] Hewitt, J. N. B., Bur. Amer. Ethnol. Archives, Smithsonian Institution, Hewitt MSS: Folder 445; obtained through the courtesy of Dr. W. N. Fenton and Anthony Wallace. Another Naked Bear story appears in Jesse Cornplanter's *Legends of the Longhouse:* 104–137. Philadelphia, 1938.

[11] Swanton, J. R., *Indian tribes of the lower Mississippi Valley and adjacent coast of the Gulf of Mexico.* Bur. Amer. Ethnol. Bull. 43. 1911.

[12] The reasons for this are easily explained. In the first place, early man in this country was not the picture writer that his European contemporary was. Further, except for a few isolated spots such as are found in the Southwest and the high plateau regions, this country seems peculiarly unsuited to the preservation of prehistoric remains, and ancient man, being nomadic, did not use the caves to the extent that the Europeans did. Of course, it would be difficult to connect him with any animal, let alone one particular beast.

[13] Cotter, J. L., *The occurrence of flints and extinct animals in pluvial deposits near Clovis, New Mexico: Pt. LV, Report on excavation at the gravel pit.* Proc. Acad. Nat. Sci. Philadelphia **89:** 15. 1937.

It is, I think, significant to note that when mammoth bones were found in Europe they were thought to be the bones of everything from giants to saints, but the idea that they were the bones of an extinct animal was not considered until comparatively modern times. And it was the ancestors of these people who painted pictures of mammoth hunts on cave walls.

At this point it would be well to return to a remark made earlier concerning *ipso facto* myths. In both China and Siberia there are numerous remains of the mammoth to be found. In the latter region frozen carcasses have been found embedded in glacial ice when a spring freshet or some other natural phenomenon exposed them to view. Natives in both regions who saw the remains naturally tried to explain the phenomenon. They found only the dead creatures, and these carcasses were buried in the ground. How could this be? Obviously, they thought the creatures lived underground. Why couldn't one be caught alive? Because they were vulnerable to light and air and died instantly upon being exposed thereto. Thus, in Siberia the mammoth was referred to as a giant mole, and in China he is called "yen-men," burrowing ox. In none of these legends do we hear of stiff legs, a waving trunk, or their capacity for drinking water, nor is any great emphasis placed on their ferocious disposition. Obviously the stories told about them have been fashioned to fit the monster in his present state, just as was done among Indians of this continent who called the bones those of the devil or of a rabbit.[15]

We now come to the questions of how long legend can be retained without stimulus, and what was the date of departure of the mammoth from this continent.

During the seventeenth, eighteenth, and early nineteenth centuries we find many dissertations attempting to prove, first that the mammoth did exist in some remote part of the country, and later that the bones were more or less contemporaneous with the white men's coming. There are stories about finding the sinews, the arteries, the stomach, and a host of other perishable parts among the osseous remains. There are stories about finding mammoth hair in a bog. In one instance the Indians who brought in bones of a mammoth stated that they had seen the beast's head with a long nose and the mouth underneath. Thomas Jefferson and others reported that there were, at that time, some of these great monsters living far away in the wilderness. All of which, if true, would be convincing evidence of a late extermination of the creatures in question.

However, in all these stories there have been flaws. The mammoth hair turned out to be a form of algae. The mammoth head described by the Indians could have been the skeletal remains of a mammoth head with the long tusk sockets protruding and looking—to the untutored eye—like the nostrils of the animal. These and other stories have, as Dr. Eiseley points out with great completeness, been proved fabrications, and as yet we have no evidence of extinction of these beasts more recent that the late Pleistocene age.[16]

In a forthcoming article Dr. Eiseley will give evidence as to why these stories were so prevalent up to almost the present century. It seems that theology and science in the eighteenth century came to a sort of understanding. The Bible stated that all creatures were preserved on the ark, the clean animals in sevens, the male and his female and the unclean animals in twos, the male with his female to repopulate the earth.[17] The clergy argued that if this were the case and the Lord went to the trouble to preserve all creatures once, then it would be inconsistent of Him to allow some to perish from the earth. It would, they felt, be an inconsistency in a constant being, that could not occur. Science went along with this idea and strove mightily to uphold it. When scientists saw the bones of the mammoth they tried to find evidence of recent death, and those who seek often find. When they heard the story of these beasts from the natives, they pressed the point of where they might be found. And the natives, to please the strange White Man, pointed vaguely off toward the unexplored and said, "There." Even Thomas Jefferson believed this idea and expressed the opinion that it was impossible for such creatures as Behemoth to be extinct. With this attitude he was more than grateful for any slight glimmer of hope that somewhere, in the land over the hill, the beasts might be found.

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[14] Tyler, E. B., *Researches into the early history of mankind and the development of civilization:* 314. London, 1878.

[15] *Ibid.:* 311–320.

[16] Eiseley, L. C., *Men, mastodons and myth.* Sci. Monthly **62**: 517–524. 1946.

[17] Genesis 7: 2.

As to how long the memory of man can retain items is a question. The impact of the story has a great deal to do with the retention. The vehicle in which it is kept also has a lot to do with it. For example, stories connected with religion usually last longer than stories for story's sake. The Jews have kept their legends fresh for at least 4,000 years. But that is a written, not oral story. However, when a comet struck the Arizona desert 4,000 or 5,000 years ago some primitive people saw the literally earth-shaking event and today the account of this incident is to be found in the sun dances of their descendants. This is established fact. In New Brunswick the Malecite will tell you that at one time the St. John River ran uphill until a culture hero Mekumwesu made it go the other way. It is possible that this legend refers to a time when the St. John had not broken through the Falls of St. John. If so, this is in the thousands-of-years-ago era. In the north we are told that it once grew very cold and never warmed up. The land was covered with ice and snow, and the game disappeared until the condition was rectified by a culture-hero. This could refer to the ice age. It could also be a romanticized idea of summer. In the Amazon region there are myths concerning a large red-faced monkey that fits none of the monkeys living in South America today. However, there once was, in post-Pleistocene times, a large primate of this type in South America.[18] Although only the tale of the comet has been definitely proved of antiquity, the others smack strongly of beliefs dating from the last glaciation.

Although this paper deals primarily with the stiff-legged motif, it has been necessary to include other stories that we might more clearly round out the picture of the beast under discussion. From the description given, we find we have a creature strongly resembling only one thing—the mammoth. That this story is an importation from Europe is, from the evidence, improbable for the following reasons: (1) The stories relating to the mammoth are too widely scattered to be of white origin. (2) The stories differ widely among themselves, some lacking the stiff-legged motif entirely and, except that they describe the same animal, lacking the patterns one would expect in a myth with a common source. (3) When some of these stories were first related they contained much physical description that the European tale lacked entirely and that could hardly be called embroidery.[19] (4) These descriptions fitted what we know today to be the physical appearance of the mammoth, and when these stories were first told the white man did not know of the mammoth and therefore would not have described him. Thus, we are brought to the conclusion that the Indian must have remembered such a beast at one time in the ancient past. Furthermore, since no evidence has been brought forth to show that the mammoth existed after the Pleistocene age, we must consider that this memory dated back to that time. Without physical evidence to prove it, we dare not date the mammoth later.

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[18] TYLER (*op. cit.*) points out that remains of a large post-Pleistocene monkey have been discovered. However, he feels that, since the monkey stood only about 4 feet high, the tale may still have validity in referring to some yet larger creature.

[19] It is important to note that the Indian version of this myth differs widely from the European version. In Europe, we have a paucity of physical description and a host of peculiar attributes such as being able to talk, producing young only when standing in ice water, fear of mice, and a sort of mutual-aid society that assisted the fallen to rise. If this were an imported story, it seems strange that all these trappings were deleted. The Indian, on the other hand is strong in his physical descriptions that, for the most part are not to be found in any of the European variants and, in fact, were unknown to Europeans until modern times. This, more than any other fact, would seem to substantiate the claim for a separate origin in this country.

There are only two more questions to be discussed, and they are the stiff-legged motif and why the myth continued to exist. Both of these can be answered simply. The taking of a beast such as the mammoth with nothing but spears, as supposed by some archeologists, must have been a titanic event. It would have been an epic struggle each time it occurred. Also these creatures did not become extinct overnight. As they diminished in numbers the taking of them became more and more of an event, until toward the close of their career it would prove to be the battle of a generation. As to the stiff-legged motif, that too is simple. The cylindrical quality of the leg and the shuffling walk would lead the untutored to suspect lack of articulation, which in turn, after physical contact with the mammoth had been lost, would point to the following rationalizations: (1) That such a beast would be unable to arise, if he once lay down, and (2) that he had jointless legs because of their shape and the shuffle. However, all things must sleep, and to sleep they must lie down. But, this animal cannot lie down; therefore he leans against a tree for support. Weaken the support and down comes mammoth, tree, and all.

Perhaps, if we allow ourselves to shake from our shoulders the weight of opinion that the majority of folklore among North American Indians is of foreign origin[20] and consider it in relation to man in prehistoric times, we can aid in pushing the date of man in North America closer to its birthday and at the same time throw some light on his activities before the dawn of recorded history. Legend today is not much help because it is adulterated by outside influence and destroyed by modern interests, but the legends recounted by the early writers on this continent throw a glimmer of light on a vast quantity of folklore only scraps of which have been recorded and less of which has been subjected to modern scholarship. It is well worth remembering that a German groceryman read a fairy tale, believed it, and discovered a civilization.

[20] Though some scholars try to tie Indian folklore into European sources, others like Tyler attempt to show contact with eastern peoples before the white coming. Through myth parallels, as we have seen in the case of the burrowing motif contained here, similar stories, where conditions are similar, can spring up quite independent of one another. In the case of the mammoth we may eliminate eastern motifs, since the story does not appear to occur either in China or in Siberia, the natural path of a people migrating to North America. Europe may be disqualified also as contributing much along these lines for reasons already stated. Let us, at least, consider the thought that where a people are in contact with a creature like the mammoth such stories may arise independently.

BIOLOGY.—*An adventure in biblio-chronology.*[1] Richard E. Blackwelder, U. S. National Museum.

The determination of the actual date of publication of works on taxonomic subjects is of great importance to the study of taxonomy because of the importance that has been placed on priority of publication. It is essential to know accurately the date of publication of the part of any work in which any new biological entity is proposed.

Many different means have been employed for determining the true dates of publication of such works. Because of this, these methods themselves become of interest to taxonomists and bibliographers. The following is an account of the means that were applied to the dating of one work. In this particular case the work has little taxonomic significance, so that the value of the determination of the dates lies principally in its illustration of the methods.

In the Zoological Record for 1907 there is listed a work by A. Heyne and O. Taschenberg entitled *Die exotischen Käfer in Wort und Bild.* Upon obtaining a copy of this quarto volume from the library, we find that it consists of 262 pages of text and 39 beautifully colored plates of beetles. The title page is dated 1908, the Vorwort (Preface) is dated 1907, and no other indication of date or serial issuance appears. From this we would conclude that the Vorwort was written in 1907 and the entire work published in 1908.

If, however, the copy we examined was bound in a library where original covers are preserved, then we might expect that if the

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[1] Received April 19, 1949.

Table 1

	Dates			Included pages			
1	2	3	4	5	6	7	8
Lieferung or part number	Cover	Archiv für Naturg.	Reviews	Covers	Signatures	Archiv für Naturg.	Reviews
1	1893	(1893)*			1–6		
2	1894	(1894)			7–10		
3/4	1895	1895			11–26		
5	1896				27–34		
6	1896				35–42		
7/8	1897*	1897/1898*	1897/1898		43–58		43–58
9	1900	(1900)	1900		59–66	59–66	59–66
10	1901	(1901)	1901		67–74	67–74	67–74
11/12	1902	(1902)	1902	(74–90)	75–90	75–90	
13/14		(1903)	1903		91–106	91–106	
15/16		1904	1904		107–122		
17/18	1904	1904		(123–146)	123–138		
19/20	1905	(1905)	1905	(147–184)	139–170	141–170	
21/22	1906	1906		(171–195)	171–194	(24 pp.)	
23/24	1907	1907		(195–218)	195–218		
25/26	1907	1907		(219–262)	219–262		
27	1908*	1907	1907		Index, etc.		

* See discussion.

work appeared in parts we should find the covers bound in. These covers might provide more accurate dates. In the *Exotischen Käfer* in the Library of the U. S. Department of Agriculture there are 17 covers bound together at the back of the volume. They prove that this work appeared in 27 parts from 1893 to 1907 (some of the covers containing two parts). Presumably some pages of text and some plates appeared in each part, but in most cases no clue is given to what pages and plates were included. Since the dates on the covers show that the parts were published about a year apart, we have gained nothing unless we can determine the contents of each part as well as its date.

Several lines of investigation can yield clues to the contents of the parts and their dates of issuance. The results of each of these are shown in Table 1 for each of the 17 parts, as explained below. Certain general facts aid in interpreting these clues. Plates, being printed as separate sheets, can be issued in any order or in any quantity desired; e.g., part 1 might include plates 1 and 2, or plates 1 and 10, or plates 1, 2, 3, and 4. Text pages, on the other hand, are always printed in groups called signatures. These may be 16 or 32 pages folded together, or they may be fewer pages, but always an even number and never less than 4 except at the end of a work where a single sheet (2 pages) may possibly be used to accommodate the last part of the text. Therefore, one part of a serial publication always contains one or more signatures, and it is impossible for a signature to be divided between two parts. It is often possible to identify signatures by the folding of the sheets.

In the work at hand there are three sets of facts to be determined. These are the publication date of each part, the pages published in each part, and the plates published in each part. Taking the dates first, we examine the text of the work to see if there is any *statement* of the arrangement of the parts and the dates of them. Since there is none in this case, we turn to the covers. It is at once apparent that there are two kinds of covers, ones with number *and* date printed on them, and ones without date and with the number written in by hand in a blank provided therefore. The latter appear to be extra covers made up later when the regular stock ran out. If this is true, some other copy of the work might have all the original covers. Our bound copy has 13 of these originals, and we obtain another copy (unbound and incomplete) that has one additional one.

Table 1 (*Continued*)

Included plates								
9	10	11	12	13	14	15	16	17
Covers	Number of pls	Publisher		Plates referred to in text	Archiv für Naturg.	Reviews	Broken alike	Left over
		of cover	of pls.					
	2	K	K	1			1,16	
	2	K	K	1,2			2,17	
	4	K	K	2,3,4			3,4,6,7,	
	2	R	D	4			5,9	
	2	R	D	4,5			8,10	
	4	R		5,6,7,8,9		11,12,13,14		
	2	(O)	O	9,10	15,19	15,19		
	2	O	O	10,11		18,20		
22,23,33,35	4	B	B	11,12,13	22,23,33,35			
	4		B	14,15,16,17,18,19	(4 pls.)			21,21^{bis},24,25
	4		B	18,19,20,21,21^{bis}		(26,27,28,29)*		
30,31	2		B	22,23,24				
32,34	2		B	22,23,24,25,23		(32,34)		
36,37	2		B	26	(2 pls.)			
38,39	2		B	26,27,28				
None				28,29				
None								

Referring to Table 1, we take up each source of evidence and record the information obtained.

Column 1. The covers are imprinted with the "lieferung" or part number. This enables us to identify the double numbers and the total number of parts.

Column 2. Each cover is dated, with the exception of numbers 7/8, 13/14, 15/16, and 27. No. 7/8 is dated on another copy, and No. 27 included a title page which was dated.

Another way in which clues may be obtained from the work itself is by examining the notations that usually appear at the bottom of the first page of each signature. These sometimes include a date, but we are not lucky this time, for there is no notation at all.

With internal evidence insufficient, we must seek clues elsewhere. First we try the abstracting journals. The Zoological Record for 1907 contains a notice of the final part and implies that it was published in 1907. No earlier volumes mention the work at all.

Column 3. Each year the Archiv für Naturgeschichte publishes a volume on the entomological publications of the preceding year. This work is cross-indexed by listing under each work the reviews of it in other works. Fifteen parts of the *Exotischen Käfer* are listed in the years 1893 to 1908. The year of publication is either stated or implied for each of these 15. (Dates not directly cited but clearly implied are in parentheses.)

Column 4. The reviews listed in the Archiv für Naturgeschichte mention seven parts, giving dates either directly or by implication. No other reviews have been found.

We have now supplied dates for every part, with 10 of them verified by more than one source. In the case of No. 7/8 the date is given in two reviews as 1897/1898. Since the cover is dated 1897, it appears best to accept that. In the case of No. 27, the title page is dated 1908. Two journals list this part among the works appearing in 1907, so that we may assume that it appeared earlier than was expected, in 1907 rather than 1908.

Many of these same sources can be used for finding clues to the pages and plates included in each part. First of all we should search for a copy still in the original covers. Both the bound and the unbound copies available in this case have had the text and the plates rearranged, although the covers were not destroyed. We therefore get no direct indication of arrangement and must continue our search.

Column 5. We start with the covers. On six of these we find a list of the families dealt with. This is an indefinite clue since the families nearly always overlap the signatures.

Column 6. Next we examine the text pages themselves. We find that they were printed in 17 groups of pages (signatures) ending on the following pages: 6, 10, 26, 34, 42, 58, 66, 74, 90, 106, 122, 138, 170, 194, 218, 250, and 262. The last two appear to have been in one part, and part 17 contained only index and new title page and introduction. Thus the signatures identify the pages issued in each part. (These conclusions are verified in later columns.)

We have now identified all the page groups, but to check these, and to show further methods, we shall see what other indications we can find.

Column 7. The Archiv für Naturgeschichte references to this work cite the pages included in five parts and state that another part contains 24 pages.

Column 8. The reviews in other journals cite pages for three parts.

Only one discrepancy occurs. The Archiv für Naturgeschichte cites pages 141–170 as belonging in part 19/20. The signatures show that this is an error for 139–170, since the signature break comes between 138 and 139. Thus all the pages have been assigned to their proper parts.

For the plates we can use these same sources as well as some others. It might well be assumed that the plates appeared in numerical order, in some fixed quantity per part. Evidence from the covers shows that this would be an error.

Column 9. Certain covers carry a list of the included plates.

Column 10. Before this copy was bound, someone made a notation on each cover of the number of plates included but did not specify which plates.

Column 11. On the back cover of each part is a line identifying the printer. (An initial is used here, since we are interested only in the changes from one printer to another.) This column is inserted for comparison with column 12.

The plates carry no notations to identify the parts in which they appeared. They do have certain other clues that may help us.

Column 12. Close examination of the plates shows certain differences in the type used for the legends. This and the imprint of the lithographer on each show that four different firms contributed to the making of the plates. The plates can thus be grouped according to the lithographer, with the following results: (1) plates 1, 2, 16, 17; (2) plates 3, 4, 6, 7; (3) plates 5, 8, 9, 10; (4) plates 11, 12, 13, 14; (5) plates 15, 18, 19, 20; and (6) plates 21–39. Each group of plates may safely be assumed to have appeared in one part or in adjacent parts. This column then shows the initial of the lithographer of the plates which our final conclusions show to belong to each part. (This is for comparison with column 11.)

We can thus see that plates 1, 2, 3, 4, 6, 7, 16, 17 were published in parts 1–4, since they are by the same printer; that plates 5, 8, 9, 10, 11, 12, 13, 14 were in parts 5–8; that plates 15, 18, 19, 20 were in parts 9–10; and that plates 21–39 were in parts 11–26.

Column 13. It would seem reasonable that each plate should appear in the part in which it is first referred to, or in an earlier part. This column therefore lists the plates referred to in each part.

Looking now at the external evidence, since there is no specific indication on the plates to show where they belong, or in the text to show which plates appeared with each group of pages, we find several indications.

Column 14. The citations in the Archiv für Naturgeschichte list the plates in parts 9 and 11/12, and state that part 13/14 has four plates and part 21/22 two plates.

Column 15. The reviews listed in the Archiv für Naturgeschichte list the pages in parts 7/8, 9, and 10 and enumerate the families included on the plates of 15/16 and 19/20. From the latter we can identify the plates by examination.

We have now identified the plates of all parts except 1 to 6 and 13/14. For the former we have determined (in discussion of Column 12) that plates 1–10 and 16–17 must have been issued in the following groups: (1) 1, 2, 16, 17; (2) 3, 4, 6, 7; and (3) 5, 8, 9, 10. We assume that plate 1 appeared in part 1, and we then compare the four plates 1, 2, 16, and 17 for blemishes that would show up on two adjacent sheets, such as gluing or stapling marks, marginal tears or folds, and differences in paper. We find at once that plate 1 has an injury that is matched on plate 16 only, and appears likewise on the cover of part 1 and the text pages 1–6. This definitely establishes the fact that part 1 contained plates 1 and 16. The same procedure definitely associates plates 2 and 17, plates 3, 4, 6, 7, plates 5 and 9, and plates 8 and 10.

Table 2

Lieferung	Pages	Plates	Date
1	1–6	1, 16	1893
2	7–10	2, 17	1894
3/4	11–26	3, 4, 6, 7,	1895
5	27–34	5, 9	1896
6	35–42	8, 10	1896
7/8	43–58	11, 12, 13, 14	1897
9	59–66	15, 19	1900
10	67–74	18, 20	1901
11/12	75–90	22, 23, 33, 35	1902
13/14	91–106	21, 21 bis, 24, 25	1903
15/16	107–122	26, 27, 28, 29	1904
17/18	123–138	30, 31	1904
19/20	139–170	32, 34	1905
21/22	171–194	36, 37	1906
23/24	195–218	38,39	1907
25/26	219–262		1907
27	Index, etc.		1907

Since all the plates except four have now been placed, these four must have belonged in part 13/14, the only one not yet settled. These all belong to one lithographer-group and are approximately in their normal place in the series. It is therefore not necessary to seek further evidence.

We now have determined, through one means or another, every fact which we set out to find. These are summarized in Table 2, where the date of each page and plate may be determined. However, we still have not exhausted the possibilities of this type of research. Some further lines of investigation are suggested below.

A very careful examination of the text might reveal references to recently published literature; these would definitely show that that page of the text was published later than the work cited. Or references to our particular work which appear in other works would show that those other works are more recent. If enough of these citations can be found they may give fairly accurate clues as to date of publication.

Many libraries make direct notations of the date of receipt. Others keep such details in their accession records. These will often prove that a work appeared before a certain date. These records will sometimes also demonstrate that a work appeared in parts and may even indicate the contents of each part.

Where the date of the work of a particular writer has been questioned, because of a conflict in the priority of names, the author himself or some other contemporary writer may have published statements giving details about the work in question. These are not always listed in reviewing journals, since they may be published as commentary in a work the title of which gives no clue to this commentary.

It can thus be seen that there are many lines of inquiry that may help us in determining the details of publication of a work. It is very important that details of this type should be made known, since in many cases priority of scientific names depends solely on the date of publication. We cannot stabilize the names until we know (or at least agree upon) the dates of their publication.

BOTANY.—*Studies in* Lonchocarpus *and related genera, V: New species from Middle America and the* Lonchocarpus guatemalensis *complex.*[1] FREDERICK J. HERMANN, U. S. Department of Agriculture.

Continued investigations of available Mexican and Central American collections of the *Lonchocarpus* group has necessitated the recognition of the following novelties and realignments.

Terua Standley & Hermann, gen. nov. Leguminosarum

Frutex vel arbor parva ramis alternis; folia alterna, imparipinnata, stipulata; foliola opposita, exstipellata, integra, plus minusve punctata; paniculae 1–3 axillares; corollae alae carinae adhaerentes; stamen vexillare ima basi liberum, medio cum caeteris in tubum clausum connatum; legumen compressum suturis incrassatis, sutura ventrali dehiscens; semina 1–4, subreniformia, hilo armillato.

Shrub or small tree with alternate branches; leaves alternate, imparipinnate, stipulate, glabrous; leaflets opposite, exstipellate, irregularly translucent-punctate, the nerves (except the midrib) not impressed, the margins entire; flowers borne on axillary peduncles; calyx at maturity broadly cupuliform (urceolate in the bud); wings of the corolla strongly adherent to the apical half of the keel; stamens monadelphous, fenestrate, the basal 2 mm of the tenth stamen free; anthers two-celled, versatile, lanceolate; style arcuate; stigma minute, terminal, glabrous; legume strongly compressed, stipitate, both sutures thickened, 1–4-seeded, elastically dehiscent along the ventral (vexillar) suture; seeds subreniform, compressed, the hilum surrounded by a membranaceous ridge.

A single species is known, native to the valley of the Río Yeguare, Honduras. Because of its dehiscent pods it must be referred to the tribe Galegeae rather than to the Dalbergieae (characterized by completely indehiscent legumes) with which it has very close affinity in most other respects. It appears, indeed, to be a more markedly transitional type between the two tribes than any genus so far known. Its mimicry of *Lonchocarpus* is striking in such features as the adherence of the wings of the corolla to the keel and the clearly punctate young leaves (the translucent cells, however, tending to plug up and become opaque with age). Other lonchocarpoid characteristics, such as the conspicuous resin-blisters on calyx and corolla, the rugose, vermiculate petiolules, and monadelphous, fenestrate, stamen-tube (a structure common in the Phaseoleae and some of the Galegeae but in the Dalbergieae known only in *Lonchocarpus*, *Derris* and *Piscidia*, as pointed out by Bentham) are shared by a few genera of the Galegeae such as *Willardia*. *Terua* clearly falls nearest to *Willardia* in the Galegeae but differs from it in having the wing petals strongly adherent to the keel, the claw of the standard appendaged at the base, pods without resin-ducts, and seeds with the hilum bordered by a membranaceous collar. The genus is dedicated to Terua Williams (Mrs. Louis O. Williams), of the Escuela Agrícola Panamericana, Tegucigalpa, Honduras.

Terua vallicola Standley & Hermann, sp. nov.

Arbor gracilis (4–6 m) vel frutex (2–4 m); stipulae inconspicuae; folia 5-foliata; petioluli exstipellati, vermiculati, rugosi; foliola late elliptica vel oblongo-ovata vel ovato-lanceolata, 1.8–10 cm longa, 0.8–5 cm lata, subcoriacea, apice obtusa vel emarginata, basi obtusa vel acuta marginibus aliquantum revolutis; paniculae folia subaequantes; flores 11–14 mm longi, glabri, subtiliter nervati et canalibus resinosis dense maculati; calyx 2.5–3 mm longus maturitate 4–6 mm latus dentibus brevissimis vel obsoletis; vexillum obovatum, 11 mm longum, 9 mm latum, basi subauriculatum apice profunde emarginatum, ungue basi apendiculato; legumen ellipticum (ca. 4 x 2.5 cm) vel irregulariter oblongum (ca. 8 x 2 cm) vel lineari-oblongum (ca. 7 x 1.5 cm), apice acuto vel mucronato, coriaceum, glabrum.

Slender tree or tall shrub, 2–6 m high, with terete glabrous branches thickly dotted with stramineous lenticels; stipules rudimentary, scale-like, broadly ovate; leaves 5-foliolate, 7–15 cm long, the petioles 1.5–3 cm long, glabrous, the rachis and upper part of the petiole (terete at the base) deeply canaliculate; petiolules exstipellate, 2–3 mm long, vermiculate, strongly cross-wrinkled, shallowly canaliculate above; leaflets broadly elliptic to oblong-ovate or ovate-lanceolate, 1.8–10 cm long, 0.8–5 cm wide, subcoriaceous, the apex obtuse to emarginate, rounded to abruptly tapering at the base, 4–7 of the second-

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[1] Received March 24, 1949.

ary nerves prominent especially beneath, the margins somewhat revolute; panicles 5–10 cm long, about equaling the leaves, loosely few-flowered, the primary peduncle 1–3 cm long, secondary peduncles 3–7 mm long, with a minute (0.5 mm) ovate bract at the base, pedicels 2–3 mm long, bearing a blunt to acute, ovate bract (0.5 mm) at their base and a pair of frequently larger (0.5–1 mm), narrowly ovate bractlets about 1 mm below the flower; flowers 11–14 mm long, dark red-purple, finely and conspicuously nerved and thickly dotted with resin-ducts; calyx 2.5–3 mm long, 4–6 mm wide, more or less plainly dotted or lined with resin ducts, glabrous without except for the minutely ciliolate margin, the apical third strigulose within, the teeth very shallow or obsolete though generally prominent in the bud; standard obovate, 11 mm long, 9 mm wide, subauriculate at the base, deeply emarginate, glabrous, the center dark green, the short claw (1.5 mm) with an inverted U-shaped appendage near the base; wings with a claw 2 mm long and an oblanceolate blade 8 mm long, 2.5–3 mm wide, glabrous; keel 8.5 mm long (blade 6.5 mm, claw 2 mm), the basal half free from the wings, white-sericeous toward the apex; stamen-tube and the free portion of the filaments glabrous; ovary sericeous along both margins; style more or less ciliate along the upper margin, frequently also along the lower; legume elliptic (averaging 4 x 2.5 cm) to irregularly oblong (averaging 8 x 2 cm) to linear-oblong (averaging 7 x 1.5 cm), light brown, glabrous, coriaceous, attenuate to abruptly rounded and stipitate at the base, the apex abruptly acute to mucronate; seeds 1–4, dark reddish brown, subreniform, glossy, 6–8 mm long, 9–12 mm wide, the hilum oval, 1.5–2 mm long, surrounded by an irregular, translucent, orange-yellow collar.

HONDURAS: Dept. El Paraíso: In barranca along Río Yeguare near Las Casitas, alt. 900 m, Dec. 4, 1946, *L. O. Williams & A. Molina R. 11072* (F—type); in quebrada along creek near Las Casitas, alt. 850 m, Jan. 5, 1947, *L. O. Williams & A. Molina R. 11532* (F); scrub forest near Las Casitas, alt. 850 m, Nov. 16, 1947, *L. O. Williams & A. Molina R. 13414* (F); rocky stream bank, vicinity of Galeras, 800–900 m, Jan. 5, 1947, *Standley et al. 1991* (F; USNA); oak forest on Montaña de Yuscarau, alt. 2000 m, Dec. 7, 1947, *A. Molina R. 602* (F). Dept. Morazán: along junction of Gallo and Jicarito Creeks, Jicarito, alt. 1000 m, June 19, 1947, *A. Molina R. 145* (F); grassy slopes in pine forest near San Antonio, alt. 1200 m, July 17, 1947, *A. Molina R. 336* (F); dense moist forest, Quebrada Seca, on road between El Zamorano and San Antonio de Occidente, alt. ca. 900 m, Aug. 5, 1947, *Standley 11745* (F; USNA).

Lonchocarpus lasiotropis, sp. nov.

Arbor 7–30 m; stipuli acerosi, strigosi, 6 mm longi; folia 13- (interdum 11- raro 9-) foliata; foliola elliptico-lanceolata, acuminata, chartacea, epunctata; inflorescentia terminalis, paniculis racemiformibus laxifloris; pedicelli 3–3.5 mm longi, fulvo-strigosi bracteolis duobus lanceolatis medio praediti; flores 10–12 mm longi; calyx cyathiformis dente carinali (1–1.5 mm longo) deltoideo-acuminato insigni; vexillum extus uberrime sericeum; alarum auriculae pusillae; carinae petala semiorbicularia spisse sericeo-strigosa trichomis rigidis albis ensiformibus 0.75 mm longis margine inferiore fere ubique connata; fenestra basi columnae filamentarum 1 mm longa, 2 mm lata; ovarium 6–7-ovulatum; legumen ignotum.

Tree 7–30 m high, up to 75 cm in diameter, with terete glabrescent branches thickly dotted with prominent lenticels, the branchlets strigose to strigose-puberulent; stipules semipersistent, narrowly linear to awl-shaped, 6 mm long, 1 mm or less wide at the base, strigose without; leaves generally 13-, sometimes 11-, rarely 9-foliolate, 14–29 (averaging 23) cm long, the subterete petiole 4.5 (3)–5.5 cm long, this and the canaliculate rachis more or less strigose, the latter usually densely so; petiolules 3–5 mm long, strigose or hirtellous, dark brownish green, rather shallowly canaliculate above, frequently parasitized and then tubercled; leaflets stiffly chartaceous, elliptic-lanceolate, the blade 4–10 cm long, 1.75–4 cm wide, dark green and glabrous or sparsely strigose above, paler and strigose beneath, epunctate, the apex acuminate, the base acute or somewhat rounded, lateral veins about 15 pairs, stramineous, very prominent especially beneath; inflorescence terminal, the panicles 10–15, racemiform, loosely flowered, 5–14 cm long; primary peduncle subterete at the base, angled above, more or less appressed-puberulent, floriferous to within 1–2 cm of the base; secondary peduncles 0.5–1 mm long, strigose, two-flowered; pedicles 3–3.5 mm long, tawny-strigose, the caducous bractlets lanceolate, 1.5 mm long, strigose, attached midway on the pedicel; flowers 10–12 mm long, "pinkish to lavender" (Yuncker et al.); calyx cyathiform, rigid-chartaceous, 3 x 5–6 mm, densely tawny-strigose, the upper teeth almost obsolete, the lateral minute (0.5 mm), the carinal prominent (1–1.5 mm), deltoid-acuminate; standard obovate-orbicular, 11–13 x 10–11 mm, copiously sericeous-strigose without, glabrous within, emarginate and slightly cucullate at the apex, tapering to the short auricles at the base, the claw (2.5 mm) thickened, extended as a short (0.25 mm) callous above each auricle; wings 13 mm long (the claw 4 mm), 4.75 mm wide, oblique-oblong, the vexillar margin elevated at the base and very slightly prolonged forming a short auricle, long-sericeous without along the median line, adnate to the keel near the base; keel petals 12.5 mm long (the claw 4.5 mm), 4.5 mm wide, semiorbicular, their lower margins united from just below the apex to within 2 mm of the claw, copiously sericeous-strigose with long (0.75 mm), stiff, white, flattened trichomes; stamens monadelphous, glabrous, the tube broadly fenestrate at the base, the vexillar stamen free only at the opening (1 mm) and there much broadened; anthers versatile, two-celled, broadly elliptic, 0.4–0.5 mm long; ovary compressed, linear, sessile, densely white-strigose; ovules 6–7; style glabrous; stigma capitate; pod unknown.

HONDURAS: DEPT. OF ATLANTIDA: Solitary in open grassland near the Cangrejal River, foothills back of Ceiba, July 29, 1938, *T. G. Yuncker, J. M. Koepper, & K. A. Wagner 8670* (F; US—type); wet thicket near Tela, Lancetilla Valley, alt. 20–600 m, Dec. 6, 1927–March 20, 1928, *P. C. Standley 55495* (F; US); DEPT. OF YORO: farm 43, near Progresso, Apr. 16, 1929, *W. D. Hottle 88* (F). All three collections were distributed as *L. michelianus* Pittier. Only the type collection is in flower.

Vernacular name: "Cincho."

Closely related to the Venezuelan *Lonchocarpus margaritensis* Pittier, from which it differs in its more numerous (13 rather than 7), acuminate, strigose (rather than velutinous) leaflets, terminal inflorescence, copious vesture of the keel (the trichomes in *L. margaritensis*, too, are less than 0.5 mm long, terete and softer) and short, broad opening (2 mm wide) in the stamen-tube (in *L. margaritensis* the opening is narrow and fully 2 mm long). Among the Middle American species, *L. orizabensis* Lundell (*L. affinis* Pittier, non Wildem.) is perhaps nearest *L. lasiotropis* but that species is at once distinguishable by its conspicuously impressed-nerved leaflets and its densely flowered, spiciform panicles with ferruginous-villous indument, filiform bractlets and small flowers.

Lonchocarpus venustus, sp. nov.

Arbor 6–10 m; folia 5–7-foliata, 20–30 cm longa; petioluli 8–10 mm longi dense puberulenti; foliola ovata vel ovato-lanceolata, 5–16 cm longa, conspicue punctata; paniculae 2–4, axillares, spiciformes densifloraeque; pedicelli 2.5–3 mm longi, strigosi; flores 10–12 mm longi; calyx cupuliformis margine undulata; vexillum late orbiculare; basi auriculatum margine involuta; alae obliquo-oblongae; carinae petala margine inferiore per dimidium terminale connata; ovarium 6–7-ovulatum; legumen ignotum.

Tree 6–10 m high, 25 cm in diameter, with "slippery gray bark" (Alexander and Hernández) and terete, glabrous branches; stipules small (1 x 2 mm), broadly ovate; leaves 5–7-foliolate, 20–30 cm long, the terete, often somewhat striate petiole (4–6 cm long) and subterete or slightly canaliculate rachis appressed-puberulent, becoming glabrate; petiolules 8–10 mm long, densely puberulent, canaliculate toward the blade, generally more or less rugose (especially that of the terminal leaflet) at least beneath; leaflets rather thick- or leathery-chartaceous, abruptly acuminate to (rarely) acute at the apex, conspicuously pellucid-punctate, glabrous above, densely appressed-puberulent becoming glabrate beneath, the 6–8 pairs of lateral veins prominent beneath, the lateral leaflets unequally ovate to ovate-lanceolate, the blade 5–11 cm long, 2.8–6 cm wide, the inner side rounded at the base, the outer cuneate, the terminal leaflet elliptic-ovate, the blade 10–16 cm long, 6–8 cm wide, cuneate at the base; panicles 2–4, axillary, spiciform, densely flowered, 22–32 cm long, the primary peduncles striate at the base becoming sharply angled above, rather sparingly appressed-puberulent, floriferous for three-fourths of their length; secondary peduncles 2 mm long, two-flowered, strigose, crowned with a pair of minute (0.5 mm), ovate, strigose, caducous bracts; pedicels 2.5–3 mm long, strigose, bearing a pair of subulate, strigose bractlets (1 mm long) at or below the middle; flowers 10–12 mm long, "light rose-lilac, with a white spot [at base of standard?], very fragrant" (Alexander and Hernández); calyx cupuliform, 3 x 4–5 mm, sparsely strigose, the lower half yellowish green and frequently purple-spotted, the terminal half cinnamon-brown, the margin undulate, the teeth (except the deltoid carinal tooth, 0.5 mm long) almost obsolete; standard broadly orbicular (12 x 13 mm), sericeous without and in the center and along the median longitudinal axis within, deeply emarginate, involute at the auriculate base forming crests or flaps 1 mm high on the inner margins of the auricles, the claw 2 mm long; wings 11–12.5 mm long (the claw 4.5 mm), 5 mm wide, oblique-oblong, auriculate at the base on the vexillar margin, sericeous without along the median line, adnate to the keel near the base; keel petals 11.5 mm long (the claw 4 mm), 4.5 mm wide, their lower margins united for the terminal half, conspicuously lineate and minutely sericeous; stamens monadelphous, glabrous, the tube fenestrate at the base; anthers two-celled, versatile, elliptic, 0.75 mm long; ovary linear, somewhat compressed, sessile, densely short-sericeous; ovules 6–7; style ciliate along the lower margin; stigma capitate; pod unknown.

MEXICO: Guerrero: Chilpacingo to Iguala, Aug. 11, 1945, *E. J. Alexander and E. Hernández Xolocotzi 151* (USNA—type: USNH); Mexico: Large tree, Bejucos, alt. 610 m, Dist. of Temascaltepec, Aug. 26, 1932, *G. B. Hinton 1473* (F); Limones, Dist. of Temascaltepec, Aug. 16, 1935, *G. B. Hinton 8179* (F). Both Hinton collections were distributed as *L. guatemalensis*.

Vernacular name: "Palo de Aro."

Lonchocarpus venustus has characteristics in common with *L. michelianus* Pittier, *L. malacotrichus* Harms, and *L. caudatus* Pittier. From the first of these it is readily distinguished by its elongate, densely-flowered panicles, its short secondary peduncles (2, rather than 4–5, mm long) and pedicels (2.5–3, rather than 6–7, mm long), and its fewer and much larger leaflets. Distinctions from *L. malacotrichus* are more difficult to give with certainty because that species is still known in this country only from the description and a fragment of the type specimen. The latter shows the presence of large bractlets at the base of the calyx which are not present in *L. venustus*, and the vesture of an apparently rather young leaflet is densely villous rather than appressed-puberulent. Furthermore the leaflet does not seem to be punctate, as described, although groups of cells here and there are translucent owing to insect or fungus attack. No flowering material of *Lonchocarpus caudatus* is yet known; hence the difficulty of comparing it with the present species of which the legume is unknown. The punctate leaflets of *L. venustus* should set it off readily enough from *L. caudatus*, but it is questionable whether the latter species actually is epunctate or whether puncta which may have been pellucid in the young leaves have become filled by some opaque secretion with age, this being the impression obtained when the leaflets are examined by intense transmitted light. The general shape of the leaflets, the relative lengths of petioles and petiolules and the unusually stout axillary primary peduncles are very similar in the two species. The leaves are much more nearly glabrous in *L. caudatus* than in *L. venustus*, the leaflets more coriaceous (nor do they show the cuneate base which prevails in the outer half of the lateral leaflets of *L. venustus*) and the pedicels longer (5 mm); but until these three plants are all known in their complete seasonal transformations their true relationship must remain in doubt.

Lonchocarpus resinosus, sp. nov.

Arbor 5 m; folia 5-foliata; foliola elliptico-lanceolata, punctata, margine per dimidium terminale crenulata; paniculae 3–6, axillares, racemiformes laxifloraeque; pedicelli canescentes bracteolis duobus squamiformibus supra medium praediti; flores 13–15 mm longi; calyx cupuliformis, coriaceus, resiniferus, margine subintegra; vexillum late orbiculare canaliculis resinosis purpureis maculatum, basi profunde cordatum; alae obliquo-oblongae; carinae petala margine inferiore solum medio connata; ovarium 5–6-ovulatum; legumen ignotum.

Tree 5 m high, 25 cm in diameter, with gray bark and terete, glabrous branches; stipules minute; leaves 5-foliolate, 19–26 cm long (the terete, glabrous petioles 5–7 cm long), the rachis shallowly channeled and sparsely puberulent above; petiolules 7–8 mm long, deeply rugose, canaliculate and faintly puberulent above; leaflets coriaceous, elliptic-lanceolate to slightly obovate-lanceolate, the blade 4.5–11 cm long, 2–6 cm wide, dark green above, much paler beneath, the apex acuminate to short-caudate, the base cuneate, pellucid-punctate, the resin-ducts occasionally much elongated, glabrous above and below except the midrib and sometimes the lateral veins sparsely short-pilose, the lateral veins 5–9 pairs, very prominent on both surfaces, the margin indurated, crenulate from below the middle to the apex; panicles 3–6, axillary, racemiform, loosely flowered, 4–17 cm long; primary peduncles terete at the base, becoming striate and finally strongly angled and canescent above, floriferous for about three-fourths of their length; secondary peduncles 3–4 mm long, canescent; pedicels 4–5 mm long, canescent, with a pair of scale-like bractlets (0.75

mm) above the middle; flowers 13–15 mm long, "purplish-rose, the spot greenish-white turning purple" (Alexander and Hernández); calyx cupuliform, coriaceous, 4 x 5–6 mm, minutely and sparingly strigose, heavily lined throughout with dark purplish brown resin-ducts, the margin ciliolate, subentire, a minute carinal tooth perceptible; standard broadly orbicular, 12–13 x 14–15 mm, finely sericeous without and in the center within, dotted with purplish red resin ducts, especially toward the deeply emarginate apex, deeply cordate at the base, forming long narrow, involute auricles equaling the claw (2 mm); wings 13.5 mm long (the claw 4 mm), 5 mm wide, oblique-oblong, the vexillar margin prolonged at the base and somewhat auriculate, very sparingly sericeous without along the median line, with conspicuous broken lines of resin-ducts, adnate to the keel near the base; keel petals 14 mm long (the claw 4.5 mm), 4.5 mm wide, falcate, obtuse at the apex, their lower margins united in the center but free at either end, heavily marked with broken lines of dark resin-ducts, minutely and sparingly sericeous; stamens monadelphous, glabrous, the tube fenestrate at the base, the vexillar stamen free throughout its lower half and the filament much broadened at the base; anthers versatile, two-celled, elliptic, 0.75 mm long; ovary linear, somewhat compressed, sessile, densely short-sericeous; ovules 5–6; style sparingly sericeous below, glabrate above; stigma capitellate; pod unknown.

MEXICO: GUERRERO: Cañon de los Sabinos, ca. 60 km west of Iguala, Aug. 9, 1945, *E. J. Alexander and E. Hernández Xolocotzi 63* (USNA-type; USNH).

Vernacular name: "Rosa morada."

Apparently related to *L. michelianus* Pittier, from which it is at once set off by its coriaceous, glandular-blotched calyx, its strongly auriculate standard, bractlets distant from the calyx, elongate, loosely-flowered inflorescence and fewer, larger, coriaceous, elliptic-lanceolate, prominently veined, crenulate leaflets.

Lonchocarpus spectabilis, sp. nov.

Arbor 7 m; folia 11–15-foliata, 21–30 cm longa, rhachi petiolulisque tomentosis; foliola elliptica vel oblanceolata, epunctata, utrinque molliter strigosa; paniculae 3–5, axillares, racemiformes; pedicelli 7–9 mm longi, tomentosi; flores ca. 2 cm longi purpurei vexillo macula albida; calyx cupuliformis vel cyathiformis margine truncata vel undulata; vexillum orbiculare abrupte auriculatum; alae cymbiformes; carinae petala margine inferiore connata; ovarium 4–6-ovulatum; legumen ignotum.

Tree 7 m high, with smooth gray bark and terete, densely puberulent branches; stipules small (1.5 mm long), broadly ovate; leaves 11–15-foliolate, 21–30 cm long, the petiole (5–6 cm long, subterete), rachis and petiolules (5–6 mm long) tomentose; leaflets rather stiffly chartaceous, elliptic or oblong-elliptic to oblanceolate, the blade 3.5–9 cm long, 1.5–3 cm wide (averaging 6.5 x 2 cm), the apex somewhat acute to obtuse, rounded to gradually tapering at the base, epunctate, softly strigose above and below, with about ten pairs of lateral veins which are prominent and puberulent beneath as is the somewhat impressed midrib on both surfaces; panicles 3–5, axillary, racemiform, 18–26 cm long, the primary peduncles terete, densely puberulent, floriferous for about half their length, the secondary 2–4 mm long 2-flowered, unevenly puberulent; bracts caducous, not seen; pedicels 7–9 mm long, tomentose, bearing a pair of filiform-subulate bractlets (1.25 mm long) above the middle; flowers averaging 2 cm (15–23 mm) long, when fresh "purple with a whitish spot on standard" (Alexander and Hernández); calyx cupuliform to cyathiform, densely appressed-puberulent, in anthesis 3 mm long, 8 mm wide, the margin truncate or somewhat undulate, the carinal tooth rudimentary, the others obsolete; standard orbicular (19 x 19 mm), sericeous without, glabrous within, emarginate, abruptly auriculate, the short claw (2.5–3 mm) thickened; wings cymbiform, 20 mm long (the claw 4.5–5 mm), 8 mm wide, sparsely sericeous along the center without, exceeding the keel and adherent to it toward the base; keel petals 17–18 mm long (the claw 5 mm), 7 mm wide, their terminal half united along the lower margin, conspicuously sericeous along lower margin especially toward the broadly rounded apex; stamens monadelphous, glabrous, the tube fenestrate at the base; ovary linear, compressed, sessile, densely sericeous; ovules 4–6; style slightly hirtellous along the upper margin; stigma capitellate; pod unknown.

MEXICO: GUERRERO: Taxco to Iguala, Aug. 3, 1945, *E. J. Alexander and E. Hernández Xolocotzi 3* (USNA - type).

Vernacular name: "Gallito."

Nearest allied to *Lonchocarpus orizabensis* Lundell (*L. affinis* Pittier, non Wildem.), from which it differs in its strikingly large flowers (fully equaling those of *L. megalanthus* Pittier, which have been the largest heretofore known in the genus), the standard, wings and keel being 3 to 4 times the size of those in that species, in its rudimentary calyx-teeth and in its elongate pedicels (7–9, rather than 2–3, mm).

Lonchocarpus sinaloensis (Gentry), comb. nov.

Piscidia sinaloensis Gentry, Brittonia **6**: 316. 1948.

The paired flowers and rudimentary calyx teeth of this species, as well as its close similarity to *Lonchocarpus oaxacensis* and *L. megalanthus*, indicate that its position is properly in the genus *Lonchocarpus*.

The original description may be supplemented by the following diagnostic characters, taken from an isotype (*Gentry 5525*) and a paratype (*Gentry 5937*, distributed as *Brongniartia* sp.) in the National Arboretum Herbarium, since they become significant for the plant in its new position.

Petiolules 3 mm long, gray-puberulent, canaliculate above; leaflets coriaceous, pellucid-punctate, early glabrescent except along the veins; panicles about 12, axillary; secondary peduncles 3–5 mm long, terminated by two pedicels and a subulate, adaxial projection of the axis 1–1.5 mm long; bractlets suborbicular, 2 x 2.5 mm, densely sericeous; calyx teeth shallow in the bud, almost obsolete in anthesis; standard 15 mm wide, minutely but copiously sericeous without; wings finely sericeous along the median line and sometimes the basal half without, the blade 10–11.5 mm, the claw 6.5–7 mm long; keel petals united at the middle along their lower margin, sericeous without, glabrate within except near the lower margin; stamens monadelphous, glabrous, the tube fenestrate at the base, the margins of the opening thickened, the tube greatly broadened toward the base, the filament of the vexillar stamen widened at the base and free only at the opening (3 mm); anthers large (1 mm long), ovate, versatile but attached near the base; ovary sessile, linear, compressed, densely canescent; ovules 5.

The affinities of *L. sinaloensis* and the characteristics by which it is most readily distinguished from its nearest allies are indicated in the key to the *L. guatemalensis* group at the end of the following discussion.

Lonchocarpus guatemalensis and Allies

One of the most natural groups within the genus is comprised of *Lonchocarpus guatemalensis* Benth., widely distributed in Middle America, and the plants proposed as *L. proteranthus* Pittier (Panama), *L. oaxacensis* Pittier (Oaxaca), *L. darienensis* Pittier (Panama), *L. dumetorum* Brandegee (for reference of this name to synonymy with *L. darienensis* cf. Journ. Washington Acad. Sci. **38**: 12. 1948), *L. megalanthus* Pittier (Nayarit to Michoacán), *L. mexicanus* Pittier (Veracruz), and *L. sinaloensis* (Gentry) Hermann (Sinaloa). In Pittier's systematic arrangement affinity is indicated between only three of the seven of these plants there treated; *L. proteranthus* is isolated in his section Punctati of subgenus *Eulonchocarpus*, *L. oaxacensis* is placed near the beginning of section Epunctati and *L. darienensis*, *L. megalanthus*, and *L. mexicanus* are grouped at the end of the same section, which also falls under *Eulonchocarpus*, while *L. guatemalensis* is assigned a place in section Carinati of the subgenus *Neuroscapha*. But the legumes in the type specimen of *L. proteranthus* do not have the vexillar margin "sharp-edged or rounded"; rather it is deeply and conspicuously concave (a characteristic already noted in the half-grown fruits of the type of *L. guatemalensis* by Bentham), though it is scarcely thickened. In this respect the pods resemble those of *L. hondurensis* and *L. lanceolatus* and the plant would therefore be referable to *Neuroscapha* with as much reason as are those two species, but at any rate it must be excluded from *Eulonchocarpus*. Fruiting material of *L. guatemalensis* and *L. megalanthus*, which was either unidentified at the time of Pittier's monograph or turned up later, is characterized by the same type of pods. The leaflets of all these entities are predominently pellucid-punctate (conspicuously so in the type collections of all except that of *L. oaxacensis* where the puncta are obscure except under very strong light), so that another supposed character for distinguishing between them is found to be untenable. Leaflet shape, one of the two bases for the segregation of *L. mexicanus*, is of doubtful diagnostic value, since the leaflets in typical *L. guatemalensis* alone vary from narrowly elliptic through lanceolate and ovate to almost orbicular. *Lonchocarpus megalanthus* and *L. guatemalensis* are sometimes proteranthous and sometimes not. There appears to be no reason for assuming that others of the group are any more constant in this respect.

Apart from the amply distinct *L. sinaloensis* and *L. oaxacensis*, it is apparent that the remaining plants of this group fall into two ill-defined but generally recognizable assemblages: on the one hand *L. guatemalensis* and *L. darienensis* (which I am unable to interpret as anything but a depauperate phase of *L. guatemalensis*) and, on the other, *L. megalanthus*, *L. proteranthus* and *L. mexicanus*. The more tangible characters separating the two assemblages appear to be the following:

Flowers 13 (rarely 12)–21 mm long; calyx in anthesis generally 7 mm wide or more, usually sparsely sericeous (except in *L. mexicanus*); rachis of inflorescence glabrate; secondary peduncles usually 2–2.5 mm long . . . *L. megalanthus*, *L. mexicanus*, and *L. proteranthus*.

Flowers 10–13 mm long; calyx in anthesis generally 6 mm wide or less, usually densely sericeous; rachis of inflorescence densely canescent; secondary peduncles usually 0.5–1 mm long . . . *L. guatemalensis* (including *L. darienensis*).

These apparently salient characters are not found to be consistently correlated, however. Thus *Hinton 13745*, has secondary peduncles up to 2.5 mm long, the calyx sparsely pubescent and the rachis glabrate, but the flowers are only 11–12 mm long and the calyx only 4–5 mm wide; *Galeotti 1756* likewise has secondary peduncles 2.5 mm long and calyx often 7 mm wide but copiously sericeous, whereas the rachis is canescent and flowers rarely as long as 13 mm; *Ortega 5111*, with predominently *megalanthus* characteristics, the flowers attaining a length of even 18 mm, has rudimentary secondary peduncles; *Rose et al. 14516* has the sparsely sericeous calyx, glabrate rachis and somewhat larger bracts of *L. megalanthus* but secondary peduncles only 1.25 mm long, calyx 6 mm wide and flowers 11–13 mm long; *Lundell 2740* is *L. guatemalensis* except in wide calyces; *Gentle 2483* is *L. guatemalensis* except in long secondary peduncles, etc.

Transitional forms between typical *L. guatemalensis* (including *L. darienensis*), on the one hand, and *L. megalanthus*, *L. proteranthus* and *L. mexicanus* on the other are sufficiently frequent, in fact, as to vitiate any attempt to maintain the latter three as species. Yet because they are so readily recognizable in their extreme forms (particularly *L. megalanthus* with its strikingly showy flowers almost twice the size of those of *L. guatemalensis*), the following new combinations may prove useful to those who wish nomenclatorial designation for such extremes. The varietal category seems to be appropriate as indicating their geographic segregation: *L. megalanthus* being restricted, so far as known, to a relatively narrow area in western Mexico from Sinaloa south to northwestern Michoacán, *L. mexicanus* to southern Veracruz near the eastern coast of Mexico, and *L. proteranthus* to Panama, whereas typical *L. guatemalensis* is predominently a tree of Guatemala, British Honduras, El Salvador, and Honduras, with outlying posts in Sinaloa, Yucatán, Nicaragua, and Costa Rica.

Lonchocarpus guatemalensis Benth., var. **megalanthus** (Pittier), stat. nov.

L. megalanthus Pittier, Contr. U. S. Nat. Herb. **20**: 70. 1917.

Collections typical of this extreme are: NAYARIT: Tepic, *Palmer 1997* (F; US). JALISCO: San Sebastián, *Mexia 1784* (F; US) and *1870a* (US). MICHOACÁN: Aquila, Dist. of Coalcoman, *Hinton 15818* (US).

A fruiting collection (*Ortega 6353*) from Sinaloa can be only tentatively referred here, since it lacks peduncles and pedicels as well as flowers.

Lonchocarpus guatemalensis Benth., var. **proteranthus** (Pittier), stat. nov.

L. proteranthus Pittier, l.c. 63.

Lonchocarpus guatemalensis Benth., var. **mexicanus** (Pittier), stat. nov.

L. mexicanus Pittier, l.c. 71.

The plants of the whole *guatemalensis*-alliance may be distinguished as follows:

- Bractlets broadly orbicular, 2 x 2.5 mm; secondary peduncles (3–5 mm long) terminated by a projection of the axis 1–1.5 mm long . . . *L. sinaloensis*.
- Bractlets oblong or ovate, 1 mm or less long and wide; secondary peduncles without a projection or when rarely present this rudimentary (0.5 mm long or less).
  - Leaflets tomentellous beneath; calyx teeth prominent in anthesis; secondary peduncles slender, 3–6 mm long . . . *L. oaxacensis*.
  - Leaflets glabrous or early glabrescent; calyx teeth shallow or obsolete in anthesis; secondary peduncles stout, 0.5–2.5 (rarely 3) mm long.
    - Flowers 10–13 mm long; calyx in anthesis generally 6 mm wide or less, usually densely sericeous; rachis of the inflorescence densely canescent; secondary peduncles usually 0.5–1 mm long . . . *L. guatemalensis* (including *L. darienensis*).
    - Flowers 13 (rarely 12)–21 mm long; calyx in anthesis generally 7 mm wide or more, usually sparsely sericeous (except in var. *mexicanus*); rachis of inflorescence glabrate; secondary peduncles usually 2–2.5 mm long.

Calyx densely silvery-sericeous, almost black in appearance (actually very dark red); leaflets broadly rounded at base (Veracruz) . . . *L. guatemalensis* var. *mexicanus*.

Calyx sparsely silvery-sericeous; leaflets tapering at base.

Mature pods relatively smooth and coriaceous; calyx dark red (Panama). *L. guatemalensis* var. *proteranthus*.

Mature pods scarious (?); calyx pale reddish brown (Sinaloa to Michoacán). . . . *L. guatemalensis* var. *megalanthus*.

Obituaries

Albert Fred Woods, distinguished agricultural scientist, administrator, and educator, died at Prince Georges General Hospital near Washington, D. C., on April 12, 1948, after an illness of five months. He was born on December 25, 1866, at Belvedere, Ill., and grew up on his father's cattle ranch in Nebraska. He is survived by his wife, Bertha Davis Woods, and by two sons, Mark Winton, of the National Institutes of Health, and Winton de Ruyter, a lawyer of Dayton, Ohio.

His collegiate education was obtained at the University of Nebraska. From this institution he received the degrees B.Sc. in 1890, A.M. in 1892, and D.Agr. in 1913. Further degrees were conferred by St. Johns College, Annapolis, Md. (LL.D., 1923), and the University of Maryland (Sci.D., 1932).

At the beginning of his career Dr. Woods served as assistant botanist at the University of Nebraska (1890–93) under the renowned botanist Prof. Charles E. Bessey. While there he prepared a beautifully illustrated account of the Characeae of Nebraska, which was published as part of a general flora of the State.

During the last two decades of the nineteenth century the science of plant pathology was comparatively new in this country. In the U. S. Department of Agriculture this field of research had its official beginnings in 1886, at which time the Congress included in its appropriation a clause that provided for "investigating the needs of diseases of fruits and fruit trees, grains, and other useful plants due to parasitic fungi. . . ." Early approaches to this subject had hitherto been focused mainly on the fungi concerned. The experience of workers with plant diseases, however, had been gradually forcing them to the conclusion that the problems of pathology and physiology of plants are so intimately related as to make impossible any satisfactory solutions in pathology without entering the field of physiology. Dr. Woods's university training and experience, together with his early farm background, had peculiarly fitted him for this combined type of work. To fill this crucial need in the Federal Department of Agriculture in 1893 he was brought in as assistant chief and first assistant physiologist of its Division of Vegetable Pathological and Physiological Investigations and served in these capacities until 1901.

Prominent among his research publications during this period were those on water as a factor in the growth of plants, principles of pruning and care of wounds, the Bermuda lily disease, the mosaic disease of tobacco, fumigation of greenhouses and cold frames with hydrocyanic-acid gas, the stigmonose of carnations, and inoculation of the soil with nitrogen-fixing bacteria.

With the organization of crop research under the new Bureau of Plant Industry established in 1901, Dr. Woods was appointed pathologist and physiologist and assistant chief. His new duties made it necessary to give more of his time and attention to administrative affairs. Although deeply interested in administration, he preferred research—that was his first love. Illustrative of his inner feelings was the following advice to his son Mark, when a high-school student carrying out experiments in his basement laboratory: "If you have a chance to choose between research and administrative work, choose research." One of Dr. Woods's greatest assets as an administrator was this basic regard for research. He felt that administration should always be an actual part of research, and in all the administrative positions which he held throughout his entire active career this principle remained his guiding star.

Over these years numerous articles from his pen appeared in various journals and as Department publications. These included critical appraisals of the relationships of nutrition to plant health and of plant physiology to horticultural and agricultural development. Even at this early day, Dr. Woods had placed special emphasis on the importance of obtaining disease-resistant plants by selection or hybridization. He emphasized further that "the more we can learn of the exact nature of the normal and pathological processes taking place in cells and cell complexes the better able we shall be to get control of these changes for the good of man." In 1904, a syllabus for introductory courses in botany for agricultural students was the subject of the report of a committee of the Association of Land-Grant Colleges, of which Dr. Woods was chairman. There were also articles on fertilizers for special crops, the status of the nitrogen problem, and wastes on the farm. These further illustrate in some measure the breadth of his interests.

In 1910, he left the Department service to become dean of Minnesota Agricultural College and director of the Experiment Station. In 1917 he resigned from this position to accept the presidency of Maryland State College of Agriculture. Three years later he became president of the University as a whole and brought this institution to a Class A rating. During this period in Maryland (1917–26) he also served as executive officer of the State Board of Agriculture.

Under appointment as director of scientific work, Dr. Woods returned to the Federal Department of Agriculture in 1926, and served in that capacity until 1934. He was also director of its Graduate School from 1926 to 1941 and later emeritus director and educational adviser to the end of 1946. Under his guidance an able faculty was assembled and sound courses of study and high standards of work were established.

Under presidential appointment, Dr. Woods was a delegate to the International Conference on Agriculture at Rome in 1905; he was also a delegate to the International Botanical Congress at Vienna in the same year. He was general chairman of the Committees on Food Production and Conservation of the Maryland Council of Defense in 1917; president of the First Inter-American Scientific Conference on Agriculture, Forestry, and Animal Husbandry at Washington, D. C., in 1930; and member of the International Committee for Intellectual Cooperation of the League of Nations. For several years he served as vice-president of the Board of Trustees of International Biological Abstracts; in this capacity he was instrumental in arranging for its close cooperation with the Department of Agriculture.

He held memberships in the following scientific organizations, including high offices in many of them: American Association for the Advancement of Science (Fellow), American Phytopathological Society (charter member), American Horticultural Society, American Society of Naturalists, Washington Academy of Sciences, Botanical Society of Washington (charter member), Society of Morphology and Physiology, American Academy of Political and Social Sciences, National Research Council, and Association of Land-Grant Colleges and Universities. He also belonged to the Alpha Tau Omega, Alpha Zeta, Gamma Sigma Delta, and Sigma Xi fraternities, to the Cosmos and University Clubs of Washington, and to the Farmers' National Congress (life member).

Dr. Woods's most outstanding contributions to science concerned the virus mosaic disease of tobacco and the oxidizing enzymes in both plant and animal cells. He was among the first to give scientific proof of the infectious nature of tobacco mosaic and the first to call attention to the fact that viruses are associated with specific enzymic disturbances. For many years he had longed to follow up his early work in the light of the newer knowledge and techniques. It was therefore a source of keen gratification—after his retirement from the University of Maryland and the classified service of the Federal Department of Agriculture—that he was able again to work on some of these basic problems. In these later studies of the effects of viruses and mutant mitochondria on certain oxidizing enzymes of the cell, Dr. Woods showed that both virus infection and mitochondrial mutation are able to induce far-reaching changes in enzymic action. The main difference he found to lie in the fact that the viruses are infectious, whereas the mitochondrially induced changes are not. His studies in this field have had a stimulating influence on certain fundamental investigations of the viruses and of the mechanisms by which they act in both the plant and animal organisms, as well as of the mechanisms involved in the development of cancer.

Dr. Woods was a kindly man—always thoughtful of the welfare of others, a point on which the writer, a Vermont graduate who entered the Federal Department of Agriculture in 1908, has been able to testify over the years. He was always cooperative—both as a person and as an administrator. He was among the first to lay especial stress on the importance of cooperation among individual scientists and between the Department and the State experiment stations. He was friendly and unassuming, and an inspiration to all who came in contact with him. At the time of his death a man well known in educational circles commented thus upon him: "He was the most honest man I have ever met. Much of the good that I may have accomplished in my life I owe largely to him." In his religious outlook Dr. Woods was a liberal; he had a strong Christian faith and tried to put it into practice in his own life and relationships, but he was always extremely tolerant of the attitudes of others. He had that gift of rare personality which enabled him to stand out among his fellows as scientist, as administrator, as educator, and above all as a man.

Frederick V. Rand.

Philip Sidney Smith was born in Medford, Mass., on July 28, 1877, and died at St. Albans, Vt., on May 10, 1949. He is survived by his wife, the former Lenore Willis Kinney; a son, Sidney Butler Smith, director of libraries of the University of Vermont at Burlington; two daughters, Katherine Smith, of St. Albans, and Constance Smith Thurrell, of Denver, Colo.; and three grandchildren, Margaret Katherine Thurrell, Robert Freeman Thurrell, and Peter Westgate Thurrell. Dr. Smith's death was unexpected. He left his home in Washington on April 28 to attend a meeting of the directors of the Arctic Institute of North America in Montreal and went from there to the home of his daughter in St. Albans, Vt. He was stricken suddenly with pneumonia and died the following week. He was buried at Wolfeboro, N. H., near which place his family has had its summer home for many years.

Dr. Smith was of old New England stock. He was the only son of Sidney L. Smith and Kate Butler Smith, from whom he inherited a keen mind and strong body. His early education was at the Boston public schools and Boston Latin School and at Riverview Military Academy of Poughkeepsie, N. Y. He entered Harvard College in 1895 and graduated with the B. A. degree in 1899. After graduation he remained at Harvard as assistant and instructor of geology and physiography and carried on postgraduate work in these subjects, receiving the M. A. degree in 1900 and his Ph. D. in 1904. He was married to Lenore Willis Kinney, of Roxbury, Mass. in 1900.

Dr. Smith's early ambition was to enter the Navy, which is readily understood as his father was a retired naval officer. However, an undergraduate course in geology under Professor Shaler opened to his mind a new, previously unknown subject and from that time on the study of earth forms and processes became his absorbing interest. Geologic field work in Michigan and South Dakota impressed on him the need for wider experience than his teaching afforded, and in 1906 he left Harvard to join the Alaskan Division of the United States Geological Survey. Several years of Alaskan exploration followed, but his unusual administrative ability was so evident that in 1915 he was appointed Administrative geologist and later acting director of the Survey.

After the death of Col. Alfred H. Brooks, chief Alaskan geologist, Dr. Smith was appointed as his successor and continued as chief geologist of the Alaskan Branch from 1925 until he himself retired from public service in 1946. Although this period of more than 20 years was occupied in large part with administrative duties that interfered with extended field trips, it included two remarkable exploratory expeditions that were undertaken by him for the United States Navy as part of the study of petroleum reserves on the Arctic slope of Alaska, one in 1924, the other in 1926; a journey to the East India Islands as official delegate to the Pan-Pacific Scientific Congress, Java, 1929; an assignment of eight months as supervising engineer for the Federal Emergency Administration of Public Works in Alaska in 1933–34; and a journey to Russia as chairman of the United States delegation to the Seventeenth International Geologic Congress, U.S.S.R in 1937.

Dr. Smith is the author of many bulletins, professional papers, and other publications, dealing with Alaskan geology, mineral resources, and related subjects. His compilation and analysis of the geologic information collected by himself and other Alaskan geologists, published in 1939 under the title *Areal geology of Alaska*, is evidence of his own wide grasp of the subject and is the authoritative statement of the progress of Federal geologic surveys in Alaska up to the time of its publication. He spared himself no pains in his endeavor to express his own ideas with clearness and a precise use of words, of which his mind had a great store. He was a most thorough and helpful critic of work submitted to him by others.

Dr. Smith's various interests in earth studies is shown by his membership in national or local geologic, geographic, and other scientific or engineering societies. He was either fellow or member of the following organizations: Geological Society of America, American Association for the Advancement of Science, Association of American Geographers, Society of Economic Geologists, Society of American Military Engineers, American Geographical Society, National Geographic Society, Washington Academy of Sciences, Geological Society of Washington, American Institute of Mining and Metallurgical Engineers, American Polar Society, American Geophysical Union, Society of Professional Geographers, Science Committee, National Council of American-Soviet Friendship, Inc., and Arctic Institute of North America. In addition to membership in scientific and technical societies, Dr. Smith was a member of the Loyal Legion, Delta Upsilon Fraternity, Cosmos and Harvard Clubs of Washington, Travellers Club of Harvard, and Explorers Club of New York.

After his retirement in 1946, Dr. Smith devoted himself to writing, but gave much of his time and thought to the work of the Arctic Institute of North America, of which he was a charter associate and a member of the Board of Governors. His own experience in geologic exploration north of the Arctic Circle stimulated his interest in all problems relating to arctic conditions and thus opened an inviting field of investigation for his inquiring mind.

All who knew Dr. Smith will remember him for his hearty laugh and his unaffected friendly greeting, his keenness of mind, and his apt reply. Those who knew him best will remember him further for his unselfish generosity, his inquisitiveness that was never satisfied, and his love of books. He was a thorough believer in the idea of competition whether in work or in play, yet had more satisfaction in the feeling of having played his hand to the full than in winning the game. He had positive ideas and was firm in supporting them. Vigorous, forceful, humorous, with his analytical mind ever on the alert, impatient of anything less than perfection either in himself, or in others, he was an inspiring and stimulating companion and an invaluable friend.

Fred H. Moffit.

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J. Leon Shereshefsky, Chairman
Committee on Grants-in-Aid
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ARCHEOLOGY.—*An analysis of several Deptford-like pottery types found at a village site north of Moore's Creek, Cape Fear River, North Carolina.*[1] CARL F. MILLER, River Basin Surveys, Bureau of American Ethnology. (Communicated by FRANK H. H. ROBERTS, Jr.)

HISTORICAL BACKGROUND

Presumably about 1936 David I. Bushnell, Jr., made an archeological reconnaissance of the area around Moore's Creek on the Cape Fear River, N. C. A village site was found north of the creek and a surface collection was gathered consisting of 120 sherds. As far as the writer can determine these sherds have never been thoroughly examined. This study is an attempt to analyze the material, to determine whether it is comparable to the Deptford as found in eastern Georgia, and to present the data so as to be available to others.

The area under discussion, as far as it is known, was formerly occupied by the Cape Fear Indians, whose tribal name in their own language is unknown. Very little is known about these Indians, and the area is unknown archeologically. The Cape Fear Indians have been assigned to the Siouan group upon very slim evidence.

This group was first brought to the attention of the English in 1661 when a colony from New England made a settlement near the mouth of the Cape Fear River upon lands claimed to have been purchased from the Indians. While there the English soon made slaves of some of the Indian children under the pretense of educating them (Lawson, 1860). The Indian elders soon saw through this farce and drove the English from the area. On October 16, 1663, another settlement was attempted by a party from Barbados upon land purchased from Wat Coosa, the head chief of the tribe. This settlement, too, was abandoned a few years later. Various contemporary Indian villages were known to exist on the lower part of the river, the best known was called *Necoes*. A third attempt at settlement was made at the mouth of Oldtown Creek in Brunswick County on the south side of the river, but suffered the same fate as the others. From all indications the Indians were generally friendly toward the whites. What the influences were that brought about the rapid abandonment of all attempts at colonization are not known. Milling (1940) states that shortly after the Tuscarora War the Cape Fear Indians settled in South Carolina.

In 1695 these Indians succeeded in rescuing 52 passengers from a New England vessel which was wrecked on their shores. These whites later formed the nucleus of Christ Church Parish north of Cooper River.

The Cape Fear Indians were next mentioned by Colonel Johnson, the colonial governor of South Carolina, who listed them in his census of Indian villages in 1715. Their population is given as 206, all of which were living in five villages. The last mention of these Indians was made in 1751 in the records of the Albany Conference as one of the small friendly tribes with whom the South Carolina government desired the Iroquois to be at peace.

Mooney (1895), in writing about the tribes of this area, says:

> The tribes between the mountains and the sea were of but small importance politically; no sustained mission work was ever attempted among them, and there were but few literary men to take an interest in them. War, pestilence, whiskey and

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> systematic slave hunts had nearly exterminated the aboriginal occupants of the Carolinas before anybody had thought them of sufficient importance to ask who they were, how they lived, or what were their beliefs and opinions.
>
> The region concerning which least has been known ethnologically is that extending from the Potomac to the Savannah and from the mountains to the sea, comprising most of Virginia, North Carolina, and South Carolina. Of some of the tribes formerly within this area the linguistic connections has long been settled; of some others it is a matter of recent discovery; of others it is still a matter of doubt; while some must forever remain unclassified, for the tribes have perished from the earth without leaving a word of their language behind.

To show that Mooney was not always too clear to those interested in the Indians of this region I wish to quote Wallace (1934) as saying:

> The Siouan classification of these obscure tribes between the Santee and the North Carolina line by Mr. James Mooney is confessedly even to those who accept his conclusions "open to question at many points." Of them we know less than of any others. They were too weak to force attention, and as they lay off the main routes of the Indian trade, the speeches of their deputations or the reports of traders fill small space in the "Indian Book" in which the provincial government recorded its dealings with the natives. But even in doubtful points Mooney is supported by strong probabilities.

ARCHEOLOGICAL EVIDENCE

The sherds were first divided into groups based upon decorative types and all the characteristics of the pottery were considered: the paste, its composition, color, etc., together with surface finish, technique of decoration, and form.

In examining the paste, it was determined that all the sherds, generally speaking, were tempered with varying amounts of sand, which was the principal tempering material used. Small amounts of vegetal material as well as small, burned-clay particles were present in a number of instances. From all indications it looks as if the potters of this vicinity were not overly careful in the selection of and in the working of the raw clay before it was manufactured into vessels. Apparently the clay came from impure beds and the potters did not bother to clean it by discarding the fragments of leaves, roots or stems, or any other trash present. The whole, together with some sand, was incorporated into the paste from which most of the vessels were formed. The smoothness of the paste varies directly to the amount of the binder used; most sherds showing an even grained and well blended paste. Firing, as a rule, was well performed. Fire clouds were occasionally present.

The most predominating color is a light buff. Others ranged from a brick-red to a dull chocolate-gray. Some of the larger sherds display a complete range of color, while the majority, which are much smaller in size, are just one color. The core is dark gray or black depending upon the amount of heat used to burn the vessel. Where the core is unusually black, the two exterior surfaces appear as a light thin layer of oxidized clay.

After the vessel was fashioned and still in the plastic state both of the surfaces were roughly smoothed. In a number of instances this smoothing was carefully applied, but there is no evidence of rubbing to bring about a polish. No burnishing of any type was present.

All vessels, with the exception of a single, small, saucerlike form, conformed to a general wide-mouthed, straight-sided shape, with either a rounded or subconoidal base. No appendages of any kind were present. All lips were of simple forms, either rounded or flattened, with both types appearing on a single vessel in some cases.

Breaks occur, in a number of instances, along the adjoining line of one strip of clay with the other. From this we can show that the majority of the vessels were manufactured either by the loop coiling system or a false coiling method where bands of clay were added consecutively which completely encircled the vessel but did not spiral upward toward the rim and lip. In some of the sherds it was not sure whether the vessel was coiled or modeled. In other words, the pottery from this site is quite homogeneous in paste, temper, shape, color, and surface finish. It can be classified as belonging to possibly the oldest sand-tempered ceramic horizon in this section of North Carolina, which in turn is comparable to the Deptford horizon of eastern Georgia. This statement is further strengthened by the types of decoration present on the various sherds in the collection.

The decorative elements were applied while the vessel was still in the plastic state, and then the vessel was allowed to dry before being fired. Listing the surface treatment

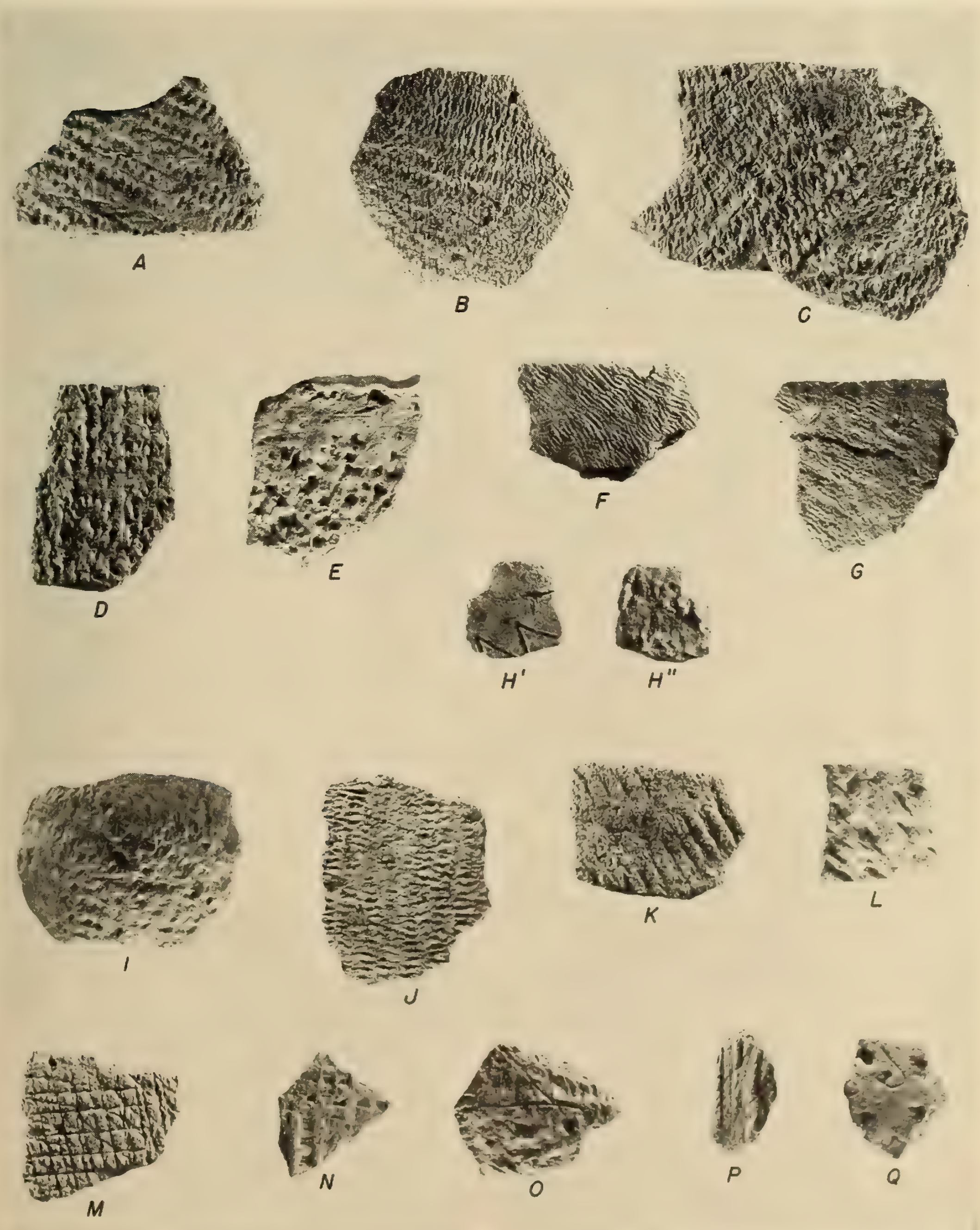

Fig. 1.—Cape Fear Pottery types: *A*, Basket impression; *B*, *C*, *G*, *H"*, and *J*, fabric impression; *D*, fine random punctation; *E*, coarse random punctation; *H'*, incised; *I*, conoidal base—check stamped (Deptford); *K*, simple stamped; *L*, large random punctate; *m*, net impressed; *N*, Deptford check stamped; *O*, incised superimposed upon crude check stamp; *P*, coarse simple stamped; *Q*, large semilunar punctate.

and decorative types, we find that the fabric impressed (Fig. 1, A, B, C, F, G, H″, J, and M) is the predominating type. This type far outnumbers all the others. Naming them in their order of dominance, we have the following: Fabric impressed, cord-wrapped paddle, fine punctate, simple stamped, incised, check stamped, plain, roughened, and coarse random punctate. A number of the sherds were so badly eroded that it was impossible to classify them. These were placed in the "indeterminate" category.

Table 1 lists the number of sherds that are available for study purposes according to the various decorative types and the percentages of each type.

Fabric-impressed pottery of this type is found to some extent throughout the Southeast and is generally associated with an early Woodland horizon. It has been pointed out by Griffin (1946) that:

TABLE 1.—POTTERY TYPES

Description	Number	Percent
Fabric impressed	74	61.6
Cord-wrapped paddle	17	14.0
Fine punctate	3	2.5
Simple stamped	3	2.5
Incised	2	1.7
Check stamped	2	1.7
Plain	2	1.7
Roughened	1	0.9
Coarse random punctate	1	0.9
Indeterminate	15	12.5
Total	120	100.0

> The cultural complexes associated with the early Woodland sites along the southeastern coast are not too clear. There is a marked unconformity between the Deptford Focus, as now defined, and the Savannah River Focus. Part of the Deptford complex may be associated with small burial mounds along the coast. There is some evidence that cord-marked pottery, formerly thought to be limited to the slightly later Wilmington Focus, and fabric impressed sherds are also contemporaneous with the Deptford level. It is reasonable to propose that the more extensive crematory practices described by Moore reached their height during the Deptford-Wilmington occupation. [p. 50]
>
> The early horizons of the area east of the Appalachians, and between the Savannah River and Pennsylvania, are imperfectly known, primarily because of the lack of systematic survey and excavation. On the upper reaches of the Pee Dee River, a series of sites, which have been grouped into the Badin Focus belong in an early Woodland period. This is indicated by predominantly stemmed and notched points; bannerstones; expended-center, bar gorget; and the almost exclusive use of plain, cord-marked pottery. If artifact typology has any chronological significance, the excavations of Fowke in western Virginia, 1894, those of the Valentine brothers in the same general area and the artifacts and ceramics gathered by Bushnell in his surface surveys of eastern Virginia (1930–1940), warrant the supposition that cultural units which will be both culturally and chronologically equivalent to the early Woodland stages of the Mississippi Valley, will eventually be identified in this area. [p. 53]

Haag (1942) classifies the Alexander series of northern Alabama as being sand tempered and cord or fabric impressed.

Griffin (1946, p. 71) states that:

> In the central Georgia area Swift Creek is said to be associated in its early stages with fiber-tempered pottery, steatite ware, footed vessels, simple stamping, plain grit-tempered ware and fabric impressed sherds. These earlier pottery types gradually disappear and by the time Swift Creek merges with Hopewellian in north Florida they are not a part of the complex.

Wauchope (1948) in discussing this type of pottery points out that:

> Since fabric impressed pottery appears at Two Run Creek in the earliest level at full strength and associated with only a small percentage of Mossy Oak Simple Stamped, and since it gradually decreases as the other early wares appear (Deptford Check Stamped and Woodstock Stamped), it is clearly the earliest majority ware in the Etowah Drainage. Since it antedates the pottery types related to the Deptford wares of coastal Georgia, I have assigned it here to the Archaic stage as defined by Ford and Willey. It is presumably later than the fiber-tempered pottery of the low country. Associated with the second layer of the village site, when Fabric Impressed was still predominant but declining, Mossy Oak had increased, and Deptford Check Stamped was coming in strong, were a flexed burial in an oval grave and a round house at what was then the ground level.

He also states that "the ceramic horizon marking the end of the Archaic and the beginning of Burial Mound I stage has not been fixed to everyone's satisfaction in any one region of Georgia."

With this as a background, we point out a number of techniques among the fabric impressed sherds as exemplified in Fig. 1, A, B, C, F, G, H″, J, and M. Some of these are of the close weft and wide warp variety including plain plaited basketry impressions. Others are of the rather loosely arranged elements with the warp and weft of equal size, while others are of a much finer weave which was fashioned to give a checkerboard effect, Fig. 1, G. A detailed description of the ware follows:

PASTE:
- Method of manufacture: Coiled; only rarely does it fracture on the juncture of the individual coil.
- Tempering: Clay particles and grit with occasionally slight evidence of vegetal material which apparently was not intentional.
- Texture: Lumpy, contorted but compact.
- Color: Ranges from grays through browns, buff, and red.

SURFACE FINISH:
- Exterior surface has been smoothed, but due to the texture of the clay the surface is uneven and lumpy in appearance. Occasional interior smudging; some fire clouds on exterior surface.

DECORATION:
- Technique: Fabric impressed—applied to the outside of the vessel. Various relative degrees of textile fineness can be noted. Impressed with plain plaited fabric. Occasionally some sherds look as though the fabric was composed of large stiff warp and small pliable weft elements which resemble basketry.
- Design and distribution: The fabric impressed design covers the entire exterior of the vessel.

FORM:
- Rim: Straight wall with no modification at rim, or only slightly on the interior where a slight thinning takes place.
- Lip: Form is usually flattened with some flattened ovate. No folding or other modification noted on most specimens. Fig. 1, E, is the exception in which the lip has been modified into a slight scalloped effect.
- Body: Walls are usually vertical on the order of a beaker, deep with no perceptible change.
- Base: Usually rounded; some slightly more so than in others.
- Thickness: Varies from 3.5 to 10 mm. The bases and lower portions of the vessels are usually thicker than the upper portions of the body, rim and lip.
- Appendages: None.

The cord-wrapped paddle is comparable to the type described by Caldwell and Waring (1939) and called *Wilmington Heavy Cord Marked*. This in turn is based upon Collins's (1932) earlier work in Mississippi. This type is assignable to the Deptford horizon. The cord elements within this type are not confined solely to the heavy cord impressions, but a number of rather fine cord impressions are also noted. In measuring the diameter of some of the cord impressions from the Moore's Creek site it was found that the diameters varied from 1.5 to 3.0 mm. As far as can be determined the cord wrapped paddle impression was applied to the entire exterior surface of the vessel. Lip forms in this type are chiefly confined to simple rounded with a minority showing a slight degree of flattening. The following is a complete description of the type:

PASTE:
- Method of manufacture: Coiled, frequently fractures on the juncture of the coils.
- Tempering: Varying amounts of fine sand, clay particles, grit, and occasional particles of vegetal material.
- Texture: Lumpy, laminated, contorted, but compact.
- Color: Ranges from a light buff through chocolate brown to reds.

SURFACE FINISH:
- Surface has been roughly smoothed while the vessel was still in the plastic state. No subsequent smoothing attempted. Owing to the texture of the clay the surfaces are uneven and lumpy. Where sand was used to any extent as tempering, the surface is rough and sandy to the touch.

DECORATION:
- Exterior surfaces have been malleated with a cord wrapped paddle or some similar implement. The cord impressions are characteristically light and have been purposedly crossed. Some of the impressions, when a positive is made of them, demonstrate that the cords were crossed on the paddle. The spacing of the elements are not regular and the decoration applied more than once to the surface. Design applied over the entire exterior surface, but not carried over the lip portion into the interior of the vessel.

FORM:
- Rim: Straight wall with no modification or folding. Occasionally there may be slight indications of folding of the rim exteriorly after the decoration has been applied.
- Lip: Usually rounded and rarely flattened.

Body: Walls are usually vertical, wide mouthed, medium deep.
Base: Rounded, varying in degree.
Thickness: Ranges from 4 to 10 mm with the thickest portions confined to the lower portions of the walls and to the bases. Appendages: None.

USUAL RANGE OF TYPE:
This type ranges along the Atlantic coast, with certain modifications, as far south as St. Simons Island and has an indefinite northern limit.

Fine punctations, applied at random over the entire exterior surface of a small number of sherds, were noted (Fig. 1, D). The individual punctations range in size from 2.0 to 3.0 mm and penetrate into the clay from 1.0 to 1.5 mm. The instrument used was a partially dulled tool, like a blunt awl, which was held obliquely to the surface giving the sloping effect to the punctation.

PASTE:
Method of manufacture: Coiling.
Tempering: Some sand, clay particles, and traces of vegetal material.
Texture: Very small particles of sand with only an occasional larger particle giving the clay a rather fine texture. Whenever clay particles are used the paste tends to be coarse owing to the size of the particles.
Color: Mostly buff shading off into a light chocolate brown.

SURFACE FINISH:
Both surfaces were roughly smoothed and no attempts made to rub the surfaces smooth or to burnish.

DECORATION:
Technique: A narrow blunt pointed implement was punched into the plastic clay at rather close intervals with no intention at design.
Design: Over-all small punctates, sloping sides with rounded bases.
Distribution: Apparently covers all of the exterior of the vessel including the lip area.

FORM:
Rim: Straight with no suggestion of flaring or incurving.
Lip: Thinned and rounded.
Body: Straight sides and vertical.
Base: Presumably either rounded or subconoidal.

Two distinct simple-stamped types are present at the site. The first (Fig. 1, K) is represented by a series of parallel impressions running diagonally to the rim and cover the entire exterior surface of the vessel. These impressions are never carried over onto the lip area. The average width of the impression is 1.5 mm. The impression of the second type was made by applying a flat, broad, striplike material which was wrapped or wound around a paddle or cylinder (Fig. 1, P), applied either by malleating or by rolling the implement over the exterior surface of the vessel. The impression was not applied with any degree of skill or care, as the markings cross each other forming, in some instances, rough diamond-shaped figures. Most of the impressions are of simple crisscross flat lines. The average width of the impressions is 3.0 mm. Even though two distinct techniques are present, there are not enough samples present in the collection to warrant elaboration.

Among the remaining types, which form a minority, are: incised (Fig. 1, H′ and O); check-stamped (Fig. 1, I and N); roughened (Fig. 1, L); and coarse random punctate (Fig. 1, E and Q). Most of these types are represented by one or two sherds, so that in reality whatever statement that can be made about these types will be of little weight.

CONCLUSIONS

The site located north of Moore's Creek on the Cape Fear River, N. C., was occupied during early Woodland times when pottery making was introduced into the area and lasted into the early part of a Deptford-like period when incised, check-stamped, punctated wares were beginning to be manifested. These types represented by either on one or two sherds, better designated as traces, may presuppose the first manifestation of these into the area. Whether these Deptford types persisted up to and just before white man's intrusion into the area can not be stated. One thing can certainly be said about the site—no trade material of European origin was found there. (This does not exclude the large cache of beads noted by Bushnell. The cache was possibly of white man's origin.) Whether this represents a prehistoric Siouan village aggregate can not be stated.

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BOTANY.—*Nomina conservanda proposals for families of seed plants.*[1] Elbert L. Little, Jr., Forest Service, United States Department of Agriculture.

In three recent articles the older name Corylaceae has been substituted for Betulaceae, by which the birch family is commonly known. To avoid disadvantageous changes of this kind, the International Rules of Botanical Nomenclature (ed. 3, 151 pp. Jena, 1935; Brittonia **6:** 1–120. 1947) include a special provision for retaining family names as *nomina conservanda familiarum* (art. 23 and art. 22, footnote). A proposal to conserve Betulaceae, therefore, would be in order. Before any additional changes in established family names are made, it has seemed appropriate to locate similar cases now, so that prompt action could be made at the next International Botanical Congress at Stockholm in 1950.

After making a brief search, I have submitted to the International Executive Committee proposals for *nomina conservanda familiarum*, as provided in the Rules (art. 21, note 1), for 12 widely used family names of seed plants which lack priority. They are Ginkgoaceae, Pinaceae, Stemonaceae, Zingiberaceae, Betulaceae, Dichapetalaceae, Vitaceae, Elaeocarpaceae, Caryocaraceae, Caricaceae, Lecythidaceae, and Onagraceae. A few other family names in use but lacking priority, which the Executive Committee may wish to consider, are mentioned also. These include Araucariaceae and Taxodiaceae, both segregates from Pinaceae. The only family names submitted in 1948 to the American Society of Plant Taxonomists for sponsorship were five others proposed by W. H. Camp (Brittonia **7:** 36–38. 1949).

More than a half century ago, a valuable, comprehensive list of family names of seed plants with citations and synonyms was prepared by John Hendley Barnhart (*Family nomenclature*, Bull. Torrey Bot. Club **22:** 1–24. 1895). Naturally, some names accepted in that list are not now in use because of differences in the rules followed. For example, a few family names without descriptions were accepted, and all family names based on synonyms were rejected there.

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[1] Received July 7, 1949. After these proposals were submitted to the International Executive Committee before the closing date July 1, 1949, the following valuable reference became available: Rehder, Alfred, *Bibliography of cultivated trees and shrubs, hardy in the cooler temperate regions of the Northern Hemisphere* (825 pp., Jamaica Plain, Mass. 1949). It contains detailed synonymy of family names within the scope of its title, including about half the names here proposed. In the Introduction (pp. ix-x), the late Professor Rehder agreed with the opinions expressed here rejecting Sprague's views on priority of family names not ending in *-aceae* and rejecting family names published in languages other than Latin. He interpreted Dammaraceae Link as a *nomen tentativum et subnudum* (p. 6).

According to Rehder's bibliography, two family names of my list had already been submitted by others. Betulaceae was briefly proposed for conservation by Janchen and Neumayer (Österr. Bot. Zeitschr. **91:** 229. (1942). Rehder himself (Journ. Arnold Arb. **26:** 278. 1945) had made a proposal for Vitaceae, though his citation of Leeaceae Horan. (1834) as the name to be rejected was later than Leeaceae Dumort. (1829), cited here. Also, Hippocastanaceae Torr. & Gray (1838) was proposed by Rehder (Journ. Arnold Arb. **26:** 278. 1945) for conservation against Paviaceae Horan. (1834), which also is prior to Aesculaceae Lindl. (1836), the name accepted here.

In his bibliography (p. x) Rehder called attention to family names published by Paulo Horaninov, *Primae lineae systematis naturae* (*142* pp., illus., Petropoli, 1834), a work overlooked by nearly all later authors. Examination of that reference reveals that two names credited to Lindley (1836) in my proposals were published earlier by Horaninov: Elaeocarpaceae Horan. (Prim. Lin. Syst. Nat. 96. 1834) and Rhizobolaceae Horan. (p. 100). Other names of that work having priority over names proposed for conservation by me and to be rejected are: Pineaceae Horan. (p. 45), an early name including Pinaceae and Araucariaceae, and Amomaceae Horan. (p. 50), for Zingiberaceae.

After the International Rules had been in use for some years, the confusion in names of families was noted by T. A. Sprague (*The nomenclature of plant families*, Journ. Bot. **60:** 69–73. 1922). Because of difficulty in ascertaining the authors and dates of publication, often two or more names were in use in the same family. The first question raised by Sprague was whether only names with the ending *-aceae* are accepted or whether names with other terminations are also accepted for purposes of priority with alteration of suffix regarded as an orthographic correction. In a review of the history of family names, he stated that the present endings of names of orders, families, and tribes, *-ales*, *-aceae*, and *-eae*, respectively, were proposed as late as 1836 by Lindley (*An introduction to the natural system of botany*, ed. 2: xiii. 1836) and were not generally adopted until many years afterward. (Also, Lindley's names terminating in *-aceae* were called orders and those in *-ales* were alliances.) Observing that Barnhart had accepted only names ending in *-aceae*, Sprague concluded that priority of a family name should date from its first publication with a diagnosis, whether or not with the suffix *-aceae*. Under either interpretation, he realized that a list of *nomina conservanda* for families, not then authorized by the Rules, would be necessary to prevent rejection of well-known names on purely technical grounds. Several cases of family nomenclature were then discussed.

Conserved family names were authorized by a change in the Rules in 1930, after Scrophulariaceae and other well-known names were found to lack priority. The history of *nomina conservanda familiarum* was summarized in a list of 186 family names proposed in 1935 by J. Lanjouw and T. A. Sprague and adopted by the Congress (Kew Bull. 1935: 79–82. 1935; Sprague, T. A., *Synopsis of proposals concerning nomenclature . . . 1935:* 62–66; Brittonia **6:** 32. 1947). Here were conserved the names of nearly two-thirds of the families of seed plants, or those employed both by Bentham and Hooker (*Genera plantarum*, 3 vols. London, 1862–83) and by Engler and Gilg (*Syllabus der Pflanzenfamilien*, ed. 9/10, 420 pp., illus. Berlin, 1924). This arbitrary list without authors or citations and including many names probably already correct under the Rules (also some greatly needing conservation) was put forward as a noncontroversial basis for preparing a complete list. It was explained that an investigation of the validity of these names would involve so much time as to be impracticable because of the lack of an adequate list of citations of family names. (From another viewpoint it seems now that the few family names needing conservation are those, such as Betulaceae, upon which there is some diasagreement.)

Present rules for names of families are few and short. Names of families are taken from the name of a genus or a synonym and end in *-aceae* (art. 23). This genus automatically is the type (arts. 18, 66). There are no further instructions on spelling. The legitimate name for a family is the earliest name published with the rank of family and in conformity with the Rules (art. 16). It is recommended that the rank be indicated when a new name of a family is published (rec. XXI). As the category of order formerly was equivalent to family, it seems proper to follow custom (art. 5) and accept as family names those ending in *-aceae* but originally published with rank of order. However, it seems that a name ending in *-aceae* published definitely with rank of a tribe should not be accepted as a family name (art. 16, footnote). A tribe or subfamily (and a suborder or an order) may become a family with alteration of the termination to *-aceae*, but the legitimate name is the earliest one with rank of family (art. 58, rec. XXXVI). Family names published merely by mention of their genera are rejected (art. 41), and only those accompanied by description or reference to previous description are validly published (art. 37). The name of a family does not change when the name of its type genus is rejected as a homonym or synonym (art. 23, as clarified in 1935). To avoid disadvantageous changes in names, *nomina* *conservanda familiarum* are retained as exceptions to priority and other Rules (art. 23; art. 22, footnote). Authors of family names are cited for purposes of precision (art. 46). However, it seems that citation of original authors of family names in parenthesis is not required (art. 49; also, Rehder, Journ. Arnold Arb. **26:** 68. 1945).

A family name with a different termination than *-aceae* (with eight special exceptions) is rejected as not conforming to the Rules (arts. 16, 23). The only authorization of change of suffix of family names is when the rank is changed (art. 58, rec. XXXVI). If all early names derived from genera but with plural endings and of whatever rank were accepted as family names, the confusion would be very great. However, the requirement that family names end in *-aceae* (art. 23) does nullify the principle of priority to a certain extent by causing rejection of older names first published with different endings. Some of the oldest names ending in *-aceae* appeared in scattered or obscure publications or in systems of classification and were not widely adopted. As noted above, the termination *-aceae* came into use before names of the categories were fixed and before the present distinction between orders and families was followed. It is to be expected, therefore, that some well-established family names require conservation under the latest Rules.

In this brief search for family names to be conserved, only names ending in *-aceae* were considered, and these were accepted if originally published as a family or an order but not as a tribe. Starting points were the lists of about 315 families of seed plants accepted by Dalla Torre and Harms (*Genera siphonogamarum*, 921 pp. Lipsiae, 1900–07), by Engler and Gilg (*Syllabus der Pflanzenfamilien*, ed. 9/10, 420 pp., illus. Berlin, 1924), and by Diels (*in* Engler, *Syllabus der Pflanzenfamilien*, ed. 11, 419 pp., illus. Berlin, 1936). Names not in the list of 186 already conserved in 1935 were then checked for priority and synonymy in Barnhart's valuable list. Then the citations involved were verified, and the names were checked with the Rules. Grateful acknowledgment is due Barnhart's list, without the aid of which these proposals could not have been prepared.

Most of the 12 family names proposed for conservation below represent large or widely known families but are antedated by obscure names. Ginkgoaceae, Stemonaceae, and Caryocaraceae are names of small families which lose priority to names taken from generic synonyms in disuse. Ten names were accepted in Engler and Prantl (*Natürlichen Pflanzenfamilien*, ed. 1). The other two, Ginkgoaceae and Pinaceae, were approved in a supplement (Nachträge II–IV Teil, 19, 21, 341. 1897). Dalla Torre and Harms (*Genera siphonogamarum*), an indispensable reference, adopted all 12 names and included citations of accepted family names. Diels (*in* Engler, *Syllabus der Pflanzenfamilien*, ed. 11) retained all except Onagraceae.

Rendle (*The classification of flowering plants*, 2 vols., illus. 1904–25) in his classification of families accepted these seven names proposed for conservation here: Ginkgoaceae, Zingiberaceae, Betulaceae, Vitaceae, Caricaceae, Lecythidaceae, and Onagraceae. Coniferae was used instead of Pinaceae, and the four remaining families, all relatively small, were not distinguished. In his new system, Hutchinson (*The families of flowering plants*, 2 vols., illus. 1926–34) adopted six of the 10 family names of angiosperms of these proposals: Zingiberaceae, Betulaceae (also Corylaceae), Caryocaraceae, Caricaceae, Lecythidaceae, and Onagraceae. The four exceptions were: Roxburghiaceae, Chailletiaceae, Ampelidaceae instead of Vitaceae, and Tiliaceae including Elaeocarpaceae.

Ginkgoaceae Engler in Engler & Prantl, Natürl. Pflanzenfam. Nachträge II–IV Teil, 19, 341. 1897.

Nom. rejic.: Salisburiaceae Link, Handb. Erkenn. Gewächse **2:** 523. 1831; in index; "*Salisburyacea*" as ordo on p. 469.

Salisburyaceae Link ex Pfeiff., Nomencl. Bot. **2:** 1024. 1874.

This family has only one living genus, *Ginkgo* [Kaempf.] L. (1771), and a single species, *Ginkgo biloba* L. (1771), a living fossil known only in cultivation. Besides this surviving species there are several fossil species of *Ginkgo* and a few fossil genera with several species extending back to the

Paleozoic era. *Ginkgo* was placed in the subfamily Taxoideae of family Coniferae by Eichler (in Engler & Prantl, Natürl. Pflanzenfam. **2** (1): 108. 1889). As soon as the microscopic details of its different life history became known, *Ginkgo* was placed in a separate family and in the new class Ginkgoales by Engler (*in* Engler & Prantl, Natürl. Pflanzenfam. Nachtr. II–IV Teil, 341. 1897).

Salisburiaceae is based upon a synonym, *Salisburia* Sm. (1797) or *Salisburya* Link (1822), and is not in use. The name was published "Salisburyacea" but corrected to Salisburiaceae in the index. The spelling Salisburyaceae was validly published by Pfeiffer and credited to Link. For uniformity in nomenclature of the categories as well as for stability, Ginkgoaceae should be conserved for this small but very distinct family.

Pinaceae Lindl., Veg. Kingd. 226. 1846.

Pinaceae Lindl., Introd. Nat. Syst. Bot. ed. 2, 313. 1836; alternative name.

Nom. rejic.: Dammaraceae Link, K. Akad. Wiss. Berlin Abhandl. 1827: 157. 1830.

Pinaceae, from *Pinus* [Tourn.] L. (1753), a genus of nearly 100 species of trees, is in universal use, though some authors recognize two or three segregate families for part of the 25 other genera. The oldest available name for the entire group apparently is Dammaraceae. Originally described in brief as the name for a segregate family, Dammaraceae is derived from *Dammara* [Rumph.] Lam. (1786–88), a synonym of *Agathis* Salisb. (1807), *nom. conserv.* As used broadly to include both *Pinus* and *Agathis*, Pinaceae must be conserved against Dammaraceae. If *Agathis* is placed in a different family, perhaps Araucariaceae also should be conserved against Dammaraceae, as noted below. It is preferable not to conserve the earlier citation, where Pinaceae was an alternative name for Coniferae, used in the following text.

Pilger (*in* Engler & Prantl, Natürl. Pflanzenfam. ed. 2, **13:** 164–165. 1926) accepted Pinaceae and three segregate families: Araucariaceae, Taxodiaceae, and Cupressaceae. The first two names lack priority and cannot be continued in use unless formally made *nomina conservanda.* These names have not been extensively adopted until recent years. However, the cases are mentioned here for action if the Executive Committee so desires. The earliest citations of the names in use and of their older synonyms, as far as I have traced them, are summarized below.

Araucariaceae Engler, Syllab. Vorles. Bot. 61. 1892. Type genus: *Araucaria* Juss. (1789). *Dammaraceae* Link, K. Akad. Wiss. Berlin Abhandl. 1827: 157. 1930. Type genus: *Dammara* [Rumph.] Lam. (1786–88), *nom. rejic.*

Taxodiaceae Schimp., Traité Paleont. Vég. **2:** 309. 1870; as "ordo." Type genus: *Taxodium* Rich. (1810). *Cunninghamiaceae* Seib. & Zucc., Fl. Jap. **2:** 1, 3. 1842 (?). Type genus: *Cunninghamia* R. Br. (1826), *nom. conserv.*

Cupressaceae Horan. (Char. Essent. Fam. Trib. Regni Veg. 26. 1847), based upon *Cupressus* [Tourn.] L. (1753), is accepted because the earlier name by the same author, Juniperaceae Horan. (Tetract. Nat. 22. 1843), from *Juniperus* [Tourn.] L. (1753), was a *nomen nudum.*

Stemonaceae Engler in Engler & Prantl, Natürl. Pflanzenfam. **2** (5): 8. 1888.

Stemonaceae Franch. & Sav., Enum. Pl. Jap. **2:** 92. 1879; *nom. nud.*

Nom. rejic.: Roxburghiaceae Wall., Pl. As. Rar. 3: 50. 1832.

This small family contains 3 genera and about 30 species, all Asiatic except for *Croomia pauciflora* in Southeastern United States. The oldest generic name in the family, *Stemona* Lour. (1790), has priority over its synonym, *Roxburghia* Banks (1795). Stemonaceae Franch. & Sav. is rejected because it was accompanied merely by mention of the constituent genera (art. 41), but the name was validly published by Engler. Sprague (Journ. Bot. **60:** 71. 1922) accepted Roxburghiaceae as the oldest name. However, Krause (*in* Engler & Prantl, Natürl. Pflanzenfam. ed. 2, **15a:** 224. 1930) justified his retention of Stemonaceae as an exception to priority because it was derived from the oldest generic name.

Zingiberaceae Lindl., Introd. Nat. Syst. Bot. ed. 2, 322. 1836.

Zingibéracées L. C. Rich., Démonstr. Bot. Anal. Fruit 61, 62, 77. 1808; *nom. subnud.*

Nom. rejic.: Alpiniaceae Link, Enum. Pl. Hort. Berolin. **1:** 2. 1821; rank between ordo and genus.

Curcumaceae Dumort., Anal. Fam. 56. 1829; as "fam."

Zingiberaceae, from *Zingiber* Boehm. [1760], *nom. conserv.*, is now generally accepted for a family of about 47 genera and more than 1300 tropical herbaceous species. This family name was adopted by Petersen (*in* Engler & Prantl, Natürl. Pflanzenfam. **2** (6): 10. 1889), by Dalla Torre and Harms, by K. Schumann (Zingiberaceae. Pflanzenreich IV. **46** (Heft 20): 1. 1904), by Loesener (*in* Engler & Prantl, Natürl. Pflanzenfam. ed. 2, **15a:** 541. 1930), and by Diels (*in* Engler, Syllab. Pflanzenfam. ed. 11, 166. 1936). Barnhart accepted Alpiniaceae as the oldest name.

The name Zingiberaceae has been attributed to L. C. Richard in 1808 in the indexes by Endlicher, Pfeiffer, and Dalla Torre and Harms. If validly published at that early date, the name would have priority. However, the Latin form Zingiberaceae was absent, but Zingibéracées appeared four times as an example in discussions of seed structure. Zingibéracées is rejected as not ending in *-aceae* (art. 23) and as merely mentioned incidentally and not accompanied by a description (art. 37).

Alpiniaceae and Cannaceae were published by Link in 1821 as his two subdivisions (rank not stated) of the order Scitamineae. He used these names again in 1829 (Handb. Erkenn. Gewächse **1:** 223, 228. 1829). Whether or not Alpiniaceae, from *Alpinia* Roxb. (1810), *nom. conserv.*, is regarded as published with rank of family, Curcumaceae must be rejected. Curcumaceae, from *Curcuma* L. (1753), was published in 1829 by Dumortier as a family but, like Alpiniaceae, was not adopted by other authors. Thus, conservation of Zingiberaceae is necessary.

Betulaceae Dumort., Anal. Fam. Pl. 11, 12. 1829; as "fam."

Betulaceae Agardh, Aphor. Bot. 208. 1825; as subdivision of "ordo."

Betulaceae Bartl., Ord. Nat. Pl. 99. 1830; as "ordo."

Nom. rejic.: Corylaceae Mirbel, Élém. Phys. Vég. 2: 906. 1815.

Both *Betula* [Tourn.] L. (1753) and *Corylus* [Tourn.] L. (1753) were pre-Linnaean names. In Barnhart's list Corylaceae was the accepted name. Fernald (Rhodora **47:** 303. 1945) adopted Corylaceae in the title of an article but without explanation. Rehder (Journ. Arnold Arb. **27:** 169–170. 1946) also took up the older name and cited detailed synonymy. More recently, George H. M. Lawrence (Gentes Herbarum **8:** 26. 1949) has followed these authors. However, as the name widely established in use, Betulaceae should be conserved for this family of 6 genera and about 100 species. Winkler (Pflanzenreich IV. **61** (Heft 19): 1. 1904) and nearly all present-day authors have accepted Betulaceae. Small (*Fl. Southeast. U. S.* 343, 345. 1903), Hutchinson (*The families of flowering plants* **1:** 222, 223. 1926), and Record and Hess (*Timbers of the New World*: 74, 137. 1943) regarded Betulaceae and Corylaceae as two separate families. If Betulaceae is conserved, those who accepted both families may continue to use Betulaceae for the family with *Betula* as its type and *Corylaceae* for the segregate family typified by *Corylus.*

Betulaceae was first published by Agardh as one of six subdivisions of his order Amentaceae. As these subdivisions have been interpreted as tribes and were not of the same rank as his orders, which now are families, it seems best not to conserve Betulaceae as published by Agardh.

Dichapetalaceae Engler in Engler & Prantl, Natürl. Pflanzenfam. **3** (4): 345. 1896.

Nom. rejic.: Chailletiaceae DC., Prodr. **2:** 57. 1825.

This family contains 4 genera and about 220 species of tropical trees and shrubs, mostly African. It is named for its only large genus, *Dichapetalum* Thouars (1806), synonym *Chailletia* DC. (1811), which has about 200 species. Dichapetalaceae was accepted by Gleason (No. Amer. Fl. **25:** 381. 1924). Engler and Krause (*in* Engler & Prantl, Natürl. Pflanzenfam. ed. 2, **19c:** 1. 1931) retained Dichapetalaceae in spite of use of the older name Chailletiaceae by certain other authors. Though Chailletiaceae has priority of many years and though Dichapetalaceae was published after the date suggested for names to be conserved, it seems that for convenience and utility the latter should be retained.

Vitaceae Lindl., Introd. Nat. Syst. Bot. ed. 2, 30. 1836.

Nom. rejic.: Leeaceae DC., Prodr. **1:** 535. 1824; as "trib."

Leeaceae Dumort., Anal. Fam. Pl. 21, 27. 1829; as "fam."

Leeaceae Bartl., Ord. Nat. Pl. 354. 1830; as "ordo."

Leeaceae, from *Leea* Royen ex L. (1767), is not in use, though adopted by Barnhart because of its priority. Leeaceae DC., published as a tribe of the order Ampelideae, probably would not be accepted, but Dumortier soon elevated the name to rank of family. Vitaceae, from *Vitis* L. (1753), was adopted by Gilg (*in* Engler & Prantl, Natürl. Pflanzenfam. **3** (5): 427. 1896) and is in almost universal acceptance for this family of about 12 genera and 600 species of mostly tropical woody vines.

Elaeocarpaceae Lindl., Introd. Nat. Syst. Bot. ed. 2, 97. 1836.

Nom. rejic.: Aristoteliaceae Dumort., Anal. Fam. 37, 41. 1829.

Elaeocarpaceae, based upon the largest genus, *Elaeocarpus* [Burm.] L. (1753), was adopted by K. Schumann (*in* Engler & Prantl, Natürl. Pflanzenfam. **3** (6): 1. 1890) and is in general use for this family of about 10 genera and 150 species in tropical and subtropical regions. Barnhart accepted Aristoteliaceae, from *Aristotelia* L'Herit. (1784).

Caryocaraceae Szysz. in Engler & Prantl, Natürl. Pflanzenfam. **3** (6): 153. 1893.

Nom. rejic.: Rhizobolaceae Lindl., Introd. Nat. Syst. Bot. ed. 2, 76. 1836.

Caryocaraceae is in general use for this tropical American family of only 2 genera and about 20 species. The type genus is *Caryocar* Allem. ex L. (1771), of which *Rhizobolus* Gaertn. ex Schreb. (1789) is a synonym. Pilger (*in* Engler & Prantl, Natürl. Pflanzenfam. ed. 2, **21:** 80. 1925) adopted Caryocaraceae without mentioning the earlier name. For convenience the later name, which now is well established, should be conserved.

Caricaceae Dumort., Anal. Fam. 37, 42. 1829.

Nom. rejic.: Papayaceae Blume, Bijdr. Fl. Nederl. Ind. 940. 1826. "Blume, Batav. Cour. 1823"; not seen.

The name of this small tropical family of 4 genera and 50 species is based upon *Carica* L. (1753), of which *Papaya* [Tourn.] Adans. (1763) is a synonym. This genus contains about 40 species. Caricaceae has been adopted by most authors, including Barnhart, Solms-Laub. (*in* Engler & Prantl, Natürl. Pflanzenfam. **3** (6a): 94, 1893), and Harms (*in* Engler & Prantl, Natürl. Pflanzenfam. ed. 2, **21:** 510. 1925).

Lecythidaceae Lindl., Introd. Nat. Syst. Bot. ed. 2, 523. 1836.

Nom. rejic.: Napoleonaceae Dumort., Anal. Fam. 28, 29. 1829.

Belvisiaceae Lindl., Introd. Nat. Syst. Bot. 180. 1830.

Lecythidaceae, from *Lecythis* Loefl. (1758), was accepted by Niedenzu (*in* Engler & Prantl, Natürl. Pflanzenfam. **3** (7): 26. 1892) and is in universal use for this family with about 17 genera and 200 species of tropical trees. Barnhart approved the earliest name, Napoleonaceae. *Belvisia* Desv. (1814) is a synonym of *Napoleona* Beauv. (1807). The name Lecythidaceae was originally published in a list of corrections. If desired, the following later citation could be conserved: Lecythidaceae Lindl., Veg. Kingd. 739. 1846.

Onagraceae Dumort., Anal. Fam. 36, 39. 1829; as "fam."

Nom. rejic.: Circaeaceae Lindl., Synops. Brit. Fl. 109. 1829; as "order."

Fuchsiaceae Dumort., Anal. Fam. 39. 1829; as "trib."

Epilobiaceae "Vent."; DC., Prodr. **3:** 35. 1828; *pro synon.*

Onagraceae was adopted by Raimann (*in* Engler & Prantl, Natürl. Pflanzenfam. **3** (7): 199. 1893) and by Dalla Torre and Harms and is in common use for this family of about 40 genera and 500 species. Barnhart and some others took up Epilobiaceae, which does not have priority, however. Epilobiaceae was published by De Candolle (Prodr. **3:** 35. 1828) as a synonym of the order Onagrariae and with the citation as "Epilobiaceae *Vent. tabl.* 3, *p.* 307." However, Ventenat (Tabl. Regn. Veg. 3: 307. 1799) had Epilobianae. Fuchsiaceae was published as a tribe under the family Onagraceae and not of the same rank. Circaeaceae appeared the same year as Onagraceae. As it is not known which name is earlier, Onagraceae should be conserved. Sprague (Journ. Bot. **60:** 71–72. 1922) accepted Onagraceae on the basis of priority from Onagrae Adans. (Fam. Pl. **2:** 81. 1763). Diels (*in* Engler, Syllab. Pflanzenfam. ed. 11, 306. 1936) adopted Oenotheraceae, which according to Barnhart was published much later by Drude (Syst. Geogr. Anordn. Phaner. 385. 1879). Sources of the names cited above are *Onagra* Adans. (1763), *Circaea* [Tourn.] L. (1753), *Fuchsia* [Plum.] L. (1753), and *Epilobium* [Dill.] L. (1753).

Chlaenaceae Thouars (Hist. Végét. Iles Austr. Afrique 46. 1807), arbitrarily conserved in 1935, was taken not from a generic name (art. 23) but from a slightly different, Greek root of the latter part of names of the 4 original genera, all published simultaneously by the same author. This small family of 7 genera and about 22 species, all confined to Madagascar, was renamed Schizochlaenaceae by Barnhart (Bull. Torrey Bot. Club. **22**: 17. 1895). The spelling Schizolaenaceae, also in use, is more appropriate, because the original form of the generic name was not *Schizochlaena* but *Schizolaena* Thouars (Hist. Végét. Iles Austr. Afrique 43, *pl. 12*. 1807), from the Latin root instead of the Greek root. The simplest course is to retain the original, conserved name Chlaenaceae. However, if the irregular derivation not from a generic name makes it an objectionable exception to art. 23, Chlaenaceae could be removed from the list of *nomina conservanda* in 1950 (art. 74).

Several small families, mostly containing only one or two small aberrant genera in each, have been added to the last editions of Engler's *Syllabus*. These family names, which were not checked, in general conform to present rules. The names Crypteroniaceae and Sonneratiaceae, which were adopted by Dalla Torre and Harms (Gen. Siphon. 343. 1903) as well as by Diels (*in* Engler, Syllab. Pflanzenfam. ed. 11, 300. 1936), lose priority to older names taken from synonyms of the type genera. Though legitimate, Heteropyxidaceae and Julianaceae appear to be based upon generic names now rejected as later homonyms. Specialists working in all these groups should decide whether family names based upon the currently accepted names of the type genera should be conserved.

In the following case the family name based upon the accepted generic name has priority over that taken from a pre-Linnaean name of the type genus: Aesculaceae Lindl. (Introd. Nat. Syst. Bot. ed. 2, 84. 1836), from *Aesculus* L. (1753). Hippocastanaceae Torr. & Gray (Fl. No. Amer. **1:** 250. 1838), from *Hippocastanum*. Both family names are widely used. However, Aesculaceae, is the proper name for the group, unless it is united with Sapindaceae, and does not require conservation.

PHYSIOLOGY.—*The endocrine glands and evolution, No. 2: The appearance of large amounts of cement on the teeth of horses.*[1] THEODORE E. WHITE, River Basin Surveys, Bureau of American Ethnology.

In 1942, in conjunction with the study of the horses of the Florida Miocene, I suggested that the folding of the enamel of the teeth might be correlated with the activities of the endocrine gland which stimulate and regulate metabolism and growth (White, 1942, p. 45). This concept has been further elaborated in a consideration of the deciduous teeth of *Hyracotherium* (in press). At the same time (1942, p. 44) I called attention to the fact that the deposition of cement on the teeth, in amounts to be functionally advantageous, necessitated a change in the animals' physiology. Also, I called attention (p. 44) to the coincidence of the geologically earliest appearance of large amounts of cement on the teeth occurring in an area in which the soil and water were excessively rich in calcium. Since the factual data on the quantity of cement on the teeth of the horses of the Florida Miocene have already been published, it is the purpose of this study to examine the deposition of a large quantity of cement on the teeth in the light of the activities of the endocrine glands.

The science of endocrinology has advanced so rapidly within recent years and the literature on the subject is so voluminous that the more recent editions of standard textbooks inevitably will not be the last word on all aspects of the science. On the other hand, this delay will permit the confirmation or refutation of the newer findings and the textbooks will represent the concensus of opinion. Consequently, I have taken the statements of the activities of the glands from the more recent textbooks rather than to try to examine the original literature.

Since there are a number of excellent textbooks, each with an extensive bibliography, dealing with the activities and abnormalities of the endocrine glands, this subject will receive only the briefest treatment here. The function of the endocrine system is to maintain the orderly function of the organs, to stimulate and regulate

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received May 18, 1949.

growth and maturation in the young, and to regulate body temperature and metabolism. In general, the function of the system is to maintain a favorable "internal environment" or *homeostasis* (Goldzieher, 1939, p. 11).

The hormones themselves are *not* species specific. All vertebrates produce qualitatively the same hormones and respond to hormonal stimulation in the same manner (*ibid.*, p. 32). Most invertebrates and Protozoa show similar responses to some of the vertebrate hormones and a few of these have been identified in various groups (three from *Paramecium*).

No single gland acts independently but is closely integrated with the functions of the other glands of the system in order to maintain an endocrine balance. The distress resulting from an endocrine imbalance, such as Graves' disease, is a function of the degree and duration of the maladjustment and may terminate in death. The relationship between the various glands may be mutually synergistic as between the thyroid and pituitary, i.e., increased activity of the thyroid is accompanied by a decrease in the secretion of the thyrotropic hormone of the anterior lobe. Or, there may be reciprocal antagonism, as between the thyroid and adrenal cortex, i.e., increased activity of one is soon followed by a corresponding increase in the activity of the other (*ibid.*, p. 93).

In order to maintain homeostasis, the endocrine glands must respond to external factors. The changes in external environment which are accompanied by changes in the activities of the endocrine glands are altitude, temperature, climate, quantity and types of foods and accessory foodstuffs, such as mineral salts and vitamins. High temperatures cause diminished activity of the thyroid with increased iodine content, while the response to cold is increased activity. Although the incidence of Graves' disease has been correlated with geography and climate, there is reason to believe that in those cases where less than radical changes in external environment prove deleterious an endocrine imbalance already existed (*ibid.*, p. 11).

Minerals occur in the body fluids in two forms: as organic compounds and as electrolytes. The proper balance of the latter is essential to health and is maintained by the diuretic action of several of the glands. An electrolyte imbalance affects certain glands depending on the mineral involved. An excess of the electrolytes of potassium inhibits the action of the adrenal cortex and increases the effectiveness of the thyroid hormone. A deficiency in calcium ions results in hyperactivity of the parathyroid (*ibid.*, p. 14).

Very little is known about the relationships of hormones and vitamins, although this has been extensively studied by many workers. Only vitamins A and D show toxic effects on unphysiologically large doses (*ibid.*, p. 17). Large doses of both vitamins A and C depress the metabolic rate of overthyroidized animals (*ibid.*, p. 88). Vitamin D is essential for the normal absorption and utilization of the lime salts taken with food and in the ossification of the skeleton (Grollman, p. 253). On the other hand, overdosage appears to have a destructive effect on bone (Goldzieher, p. 19, and Shohl, p. 153).

Much remains to be learned concerning the heredity of the endocrine glands. In the case of endocrine deficiencies as well as hyperactivity (Grollman, p. 211) there is a distinct familial resemblance. However, in view of the responsiveness of the glands to external stimuli, this may be due to foetal environment. In some deficiencies, the state of the glands of the offspring show a particular resemblance to that of the mother (Goldzieher, p. 139). Stockard (1941), working with the genetics of dog breeds, attempted to change the offspring of a hypothyroid mother by administration of thyroid during the gestation period. From negative results he concluded that the genetic relationship was unalterable. On the other hand, he overlooked the fact that the female sex hormones of the pregnant mammal very effectively inactivate that of the thyroid (Goldzieher, p. 94). On theoretical grounds, the parent-offspring relationships of the endocrine glands should follow genetic laws but as yet confirmatory evidence is lacking.

Only four of the glands will be considered here: the pituitary, thyroid, parathyroid, and the adrenal. The anterior lobe of the pituitary probably secretes a greater variety of hormones than any other one gland. Fourteen or more fractions of the anterior lobe have been isolated and tested (*ibid.*, p. 276). Half or more of these appear to be directed at a particular organ or gland and are classed as organotropic hormones. These include two gonadotropic, a thyrotropic, adrenotropic (cortex), and parathyrotropic principles. One each for the adrenal medulla, islands of Langerhans, and the spleen are suspected but not proved. In addition to the organotropic fractions, there are three special metabolic, a lactogenic, and a growth fraction (*ibid.*, p. 276). That the growth hormone is essential to growth has been demonstrated by hypophysectomy of laboratory animals, in which no growth occurred without the administration of the hormone despite an optimum diet. The administration of the hormone to normal animals has produced giant rats, but with dogs, deformities similar to acromegaly occurred (Grollman, p. 44). The thyroid hormone is also essential for growth, but is not a substitute for that of the anterior lobe (Goldzieher, p. 279). Experiments indicate that the internal secretions of the gonads are antagonistic to the growth promoting hormone. The antagonism is greater in the males than the females (*ibid.*, p. 278).

As far as is known, the thyroid secretes a single hormone, thyroxin, but its effects on the body are multiple. These effects can be divided into three major categories: metabolic, morphogenic, and general effects. The metabolic changes which accompany an increase in the activity of the thyroid are: increased oxidation, calorigenesis above certain body temperatures, diuresis, protein and fat metabolism, and calcium-phosphorus exchange. There is a corresponding decrease in these activities with a decrease in the activity of the thyroid. The increased excretion of calcium and phosphorus due to hyperthyroidism may have osteoclastic effects and lead to demineralization of the skeleton (*ibid*, p. 82). On the other hand, the increase in calcium-phosphorus exchange is not proportional to the increased metabolic rate, and if the diet is adequate, there is no evidence of failure of ossification in the young or decalcification in the adult in rats rendered severely hyperthyroid (Grollman, p. 175).

The dominant role in morphogenesis is played by the thyroid not only in the young and growing animal but in the adult as well. In tadpoles the administration of thyroid speeds up metamorphosis, and the growth and differentiation of the internal organs. However, large unphysiological doses impair growth and dwarfed animals result (Goldzieher, p. 83). That the thyroid is essential to the ossification of bone and formation of teeth is shown by the rapidity with which the abnormalities of these parts, due to thyroid insufficiency, are corrected in the young and growing animal by the administration of the hormone. The healing of fractures and cuts is speeded up by the administration of thyroid. The characteristics of the skin, hair, and nails accompanying hypothyroidism disappear with hormone medication.

The general effects of medication or increased thyroid activity include: increased irritability of nervous system with decreased reaction time, accelerated cardiac action and vasodilatation, increased peristaltic action, and increased tonus of striated muscle (*ibid.*, p. 84).

Because of their small size, the parathyroids were not discovered until relatively recently. Once their relation to certain skeletal anomalies was recognized, they began to receive attention from many workers. Their function appears to be the mobilization or retention, respectively, of electrolytes and water (*ibid.*, p. 210). In regard to water mobilization, there is a synergistic action between the parathyroid, thyroid, and anterior lobe of the pituitary while the antagonistic action, i.e., retention of water, is produced by the posterior lobe, adrenal cortex, and the pancreatic islands. The mobilization of electrolytes do not appear to be so strikingly grouped, or rather the state of knowledge does not permit such a grouping. However, there is a definite synergism between the parathyroid and thyroid in regard to calcium metabolism and a reciprocal antagonism between the parathyroid and adrenal cortex in regard to sodium.

The relationship between vitamin D and

the parathyroid is complex and requires further study. Both are essential to the ossification of the skeleton (Grollman, p. 253), but neither is a substitute for the other (Goldzieher, p. 223). They are synergistic in maintaining the level of the serum calcium but are antagonistic as regards serum phosphorus. Vitamin D causes assimilation of calcium from the digestive tract and deposition in the bone while the parathyroid extracts calcium from the bone in a low calcium diet (Grollman, p. 286, and Goldzieher, p. 19).

The limits of variation in the function of the parathyroid, without harmful results, appear to be much narrower than those of the other glands. In laboratory animals there is considerable variation in the responses to parathyroidectomy. In the Carnivora, with a high intake of phosphorus, tetanic convulsions develop in a few days on an uncontrolled diet and death soon results (Goldzieher, p. 206). However, on a diet rich in calcium, they can be kept alive much longer (Grollman, p. 252). In the herbivorous animals, whose diet is rich in calcium, acute tetanic symptoms usually do not occur, but after a month there is a deterioration of the incisor teeth of the rat (*ibid.*, p. 251).

The manifestation of natural parathyroid insufficiency is characterized by the following metabolic changes: decrease in serum calcium, increase in serum phosphorus, and decrease in elimination of both calcium and phosphorus in the urine (Goldzieher, p. 219). The deleterious results of these changes can be postponed by a diet high in calcium and low in phosphorus (*ibid.*, p. 222, and Grollman, p. 267). Without a rigidly controlled diet, vitamin D would appear to aggravate the symptoms (Goldzieher, p. 223). Other manifestations of parathyroid insufficiency are: brittleness and decay of the teeth, brittleness of the nails, loss of hair, and the formation of cataracts in the eye (*ibid.*, p. 218, and Grollman, p. 263).

The manifestation of hyperparathyroidism is characterized by increased water and calcium-phosphorus metabolism which bring about the following skeletal changes: general demineralization, fractures or other deformities, and giant cell tumors or bone cysts (Goldzieher, p. 227). The metabolic changes are accompanied by an increase in the serum calcium and a decrease in the serum phosphorus (Grollman, p. 282). The principal source of the calcium in hyperparathyroidism is the bone, but a high calcium diet may be of aid in preventing decalcification (*ibid.*, p. 283).

The administration of parathyroid extract to normal laboratory animals permits the following generalizations (*ibid.*, p. 258): large doses exert an osteoclastic effect, and induce stunting of growth and resorption of bone. Moderate doses cause softening of bone with disappearance of the trabeculae and an increase of osteoclasts. Small doses have an osteoblastic effect and produce hard and sclerotic bone.

The adrenal is a bipartite gland consisting of medullary and cortical portions. As yet no function has been clearly demonstrated for the adrenal medulla, and mammals appear to suffer no ill effects on being deprived of its hormone, epinephrine (*ibid.*, p. 408). On the other hand, that the cortex is essential to life is shown by the short survival period following bilateral adrenalectomy (*ibid.*, p. 388). There is no evidence of effects from overdosage of cortical extract except to suppress the activity of the animals adrenals (*ibid.*, p. 397). On the other hand, large doses of the extract increase weight and reduce oxygen consumption in Grave's disease, or in experimental hyperthyroidism (Goldzieher, p. 622). That the cortical hormone is antagonistic toward the thyrotropic hormone of the anterior lobe of the pituitary is shown by the fact that the simultaneous administration of the two hormones does not result in increased metabolism despite typical histological changes in the thyroid (*ibid.*, p. 93).

Cortical insufficiency is accompanied by diminished activity of the pituitary, thyroid, sex glands, and possibly also the pancreas and parathyroid (Grollman, pp. 401–402) and many of these reactions appear to be reciprocal (Goldzieher, pp. 621–624). Also cortical insufficiency leads to greater susceptibility to infections and toxins (Grollman, p. 391). In general, it can be said that disabilities of nearly all organs of the body result from cortical insufficiency and the degree of disability is proportional to the degree of insufficiency. The effects of the cortical hormone on general health fall very little short of those of the thyroid and anterior lobe of the pituitary.

Although certain aspects of mineral metabolism were mentioned in connection with the several glands, the role of calcium and phosphorus merits a brief review. These two minerals are the principal ingredients of bone and both are essential for the formation of strong healthy teeth. In the presence of vitamin D probably all, except a very small fraction, of these minerals ingested are assimilated, principally in the small intestine (Shohl, p. 84). The body retains the amount it needs and the remainder is excreted chiefly through the large intestine (Grollman, p. 253). The absorption into, and the removal from, the blood of these minerals takes place simultaneously without any great changes in their concentration in that medium (Shohl, p. 143). In general, the concentration of both calcium and phosphorus in the blood is greater in the young and growing animal than the adult, but the limits within which they can vary without disastrous results are very narrow (*ibid.*, p. 110). The factors which control the level of calcium and phosphorus in the blood are: the thyroid, parathyroid, and vitamin D. Increased activity of the thyroid results in increased excretion of both minerals through the large intestine and decreased activity has the opposite effect (Grollman, p. 175). Increased activity of the parathyroid raises the level of the blood calcium and results in an increased excretion of both calcium and phosphorus through the kidneys (*ibid.*, p. 286). Vitamin D causes increased assimilation of both minerals and diverts them to the skeleton (*ibid.*).

Also the ingestion of soluble salts of calcium raises the blood level slightly, which subsides after a few hours. This rise is usually, but not always, followed by a rise in the serum phosphorus. The lag between the two is about 4 hours (Shohl, p. 134).

Of perhaps greater importance than maintaining the concentration of these minerals in the blood is the maintenance of a relatively constant ratio between them (*ibid.*, p. 348). On a low calcium-phosphorus intake, if either mineral is low with respect to the other for any period of time rickets result. On a non-rachitic diet a low calcium balance results in increased activity of the parathyroid. Low calcium rickets is accompanied by increased activity of the parathyroid but it remains unaffected by low phosphorus rickets (Grollman, p. 286). The role of vitamin D in maintaining the calcium-phosphorus ratio is not well understood. But, if either is low with respect to the other, the administration of the vitamin tends to alter the relationship toward normal (Shohl, p. 134).

The retention of minerals in the body is subject to fluctuations at all ages. In general, the amount retained decreases with age, but there seems to be no reason to believe it ever reaches zero. Experiments in the feeding of infants show that increased retention with high intakes are obtained, not only with natural foodstuffs, but also when minerals are further increased by the addition of inorganic salts (*ibid.*, p. 329). Also, without altering the food intake the retention was higher with the administration of vitamin D (*ibid.*). In general, it can be said that the absolute amounts of calcium and phosphorus retentions are roughly in proportion to the intakes, for only when the intake is extremely low or extremely high is there any alteration of the percentage of the intake retained, at any given age (*ibid.*, p. 351).

The chemical composition of bone has received consideration from many workers. It is a complex mineral molecule of which tricalcium phosphate forms the principal part (*ibid.*, p. 32). Its mineral composition is nearly, but not quite, constant (*ibid.*, p. 141). Bone is not an inert concretion but is a vascular structure and the minerals may be readily transferred to the blood (*ibid.*, p. 140, and Grollman, p. 253). The deposition of calcium phosphate to form bone is dependent on the amount and proportion of the ingested calcium and phosphorus, the parathyroid hormone, vitamins C and D, and the presence of the enzyme, phosphatase, at the site of deposition (Shohl, pp. 142–143). In view of the delayed ossification resulting from insufficiencies of the thyroid and growth hormones, it would appear that these hormones were also essential to bone formation, but it may be only an expression of their general metabolic effects. Administration of the female sex hormone, estradiol, increases the density of bone in laboratory animals but its effects are not yet well understood (*ibid.*, p. 115).

Magnesium has been shown to prevent calcification *in vitro* (*ibid.*, p. 142), but with less than excessive doses laboratory animals show no ill effects if the calcium-phosphorus intake is adequate. A high magnesium and a low calcium-phosphorus diet produces rickets in young and growing animals (*ibid.*, p. 165).

The factors governing the formation of strong healthy teeth are not well understood and many controversial claims have been made. But it appears that an adequate intake of both calcium and phosphorus is essential, as well as sufficient vitamins C and D (*ibid.*, p. 145). That the thyroid and parathyroid hormones are also essential are indicated by the tooth defects which accompany insufficiencies of these glands. Recent studies show that the teeth, especially the dentine and cement, cannot be considered inert structures but are subject to the same changes which occur in the bones (*ibid.*, pp. 145, 341).

Under the name *metastatic calcification* are grouped those depositions of calcium and phosphorus in other than the normal areas of deposition. Their mineral composition is similar to, but not identical with, that of bone (*ibid.*, p. 153). The commonest sites of occurrence are the kidneys, stomach, lungs, and arteries, and include the tissues from which the chief secretions of acid take place. Also they include the tissues, aside from the bones, in which occur the highest concentrations of phosphatase (*ibid.*, p. 142). This condition has been induced experimentally by a high calcium intake, high phosphorus intake, and by the administration of an excess of vitamin D or parathyroid hormone (*ibid.*, p. 154).

A rare and little understood variation of this condition is known as *calcinosis universalis* in which the deposits are subcutaneous instead of in the other organs (*ibid.*, p. 154). There is a high retention of both calcium and phosphorus whether the intake is high or low, and does not appear to be correlated with the activities of the parathyroid or thyroid glands, or with calcium or vitamin D effects. Perhaps when this condition is better understood, the derivation of the armadillos, turtles, scincosaurs, and armored teleosts will be much clearer.

The environment for herbivorous mammals furnished by Florida during Lower Miocene time has already been published (White, 1942, pp. 42–44). Briefly, it may be summarized as a very favorable, if not optimum, environment; an area with a subtropical climate, probably an open, grassy woodland, populated by plants which had a high tolerance for an excess of calcium in the soil. Also, any streams (drinking water for the mammals) would be highly charged with calcium. Consequently, the herbivorous mammals inhabiting the area would be subjected to a daily high calcium intake.

Since the eruption of the permanent teeth of horses is concurrent with gonadal maturation, though the former is of longer duration, their form must necessarily have been previously determined by the growth of the dental germ. In the period prior to the onset of, and during, puberty large amounts of estrogens, androgens, and adrenal cortex hormone are discharged into the blood. These hormones have an inhibitory effect on the thyrotropic hormone of the anterior lobe of the pituitary (Goldzieher, pp. 83, 289) resulting in a decrease in the activity of the thyroid. Some cases of mild hypothyroidism do not exhibit a pathological condition of the thyroid until the onset of puberty (*ibid.*, p. 139). The decreased activity of the thyroid results in the decreased elimination of calcium and phosphorus through the large intestine and an increased deposition in the bone (*ibid.*, p. 82). Since the function of the parathyroid is not necessarily affected by the state of the thyroid (*ibid.*, p. 210), no compensatory increased activity on its part can be postulated. In young and growing animals, with an abundance of vitamin D, the retention of calcium and phosphorus is notably higher than in the adult. Also, vitamin D regulates the level of these minerals in the blood by diverting them to the skeleton where they are deposited (Grollman, p. 286). Since the cement depositing cells of the tooth sac are active at this time, it is reasonable to conclude that they, like the osteoblasts, would respond to the stimulus of vitamin D to help maintain the level and ratio of these minerals in the body fluids. Consequently, it would appear that *the deposition of a large amount of cement on the teeth of the Florida Miocene horses was the result of a high mineral intake and a temporary endocrine imbalance brought on by the maturation of the gonads.* Also, the amount of cement deposited would be a function of the degree of endocrine imbalance.

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ZOOLOGY.—*Marine Ostracoda from Tortugas, Florida.*[1] Willis L. Tressler, University of Maryland. (Communicated by Waldo L. Schmitt.)

The marine ostracods of the eastern North American coast are still imperfectly known. Brady and Norman (1889) reported on ostracods of the North Atlantic, and a few years before this, Dr. Brady (1870) described a few from the Gulf of St. Lawrence. Cushman (1906) reported on 26 species from Vineyard Sound and Woods Hole. Blake (1929, 1933) added considerably to our knowledge of American marine Ostracoda in his report on the ostracods of the Mount Desert region. Tressler (1940) listed eight species from the sand beaches at Beaufort, N. C., and Tressler and Smith (1948) made an ecological study of the ostracods of the Solomons Island, Md., region.

The present paper deals with 13 species of marine ostracods, 7 of which are believed to be new, from the Dry Tortugas, Fla. The material was largely obtained by Dr. Waldo L. Schmitt, U. S. National Museum, from debris secured in the course of otter trawl hauls and from the cracking up of corals and rocks, seaweed washings, and rock scrapings. Only two species were otherwise collected; these were from the alimentary tracts of fish dissected by Dr. Harold W. Manter, of the University of Nebraska. The distribution of the species in the Tortugas area is shown in Table 1.

The slides of the dissected and figured specimens, together with the alcoholic material, have been deposited in the U. S. National Museum as type specimens.

Suborder Myodocopa

Family CYPRIDINIDAE

Subfamily Cypridininae

Genus **Cypridina** Milne-Edwards

Valves moderately tumid of more or less oval shape with smooth surface. Frontal incisure deep and occurring nearly in the middle of the anterior border. Eye well developed in both sexes, but larger in the male. Frontal tentacle short, clavate. Anterior antenna 7-articulate and similar in both sexes. In most cases the posterior antenna has an endopodite that is not transformed in the male. Furca with at most 12 claws.

Cypridina squamosa G. W. Müller

Fig. 21

Cypridina squamosa G. W. Müller, F. Fl. Neapel **21**: 207. 1894.

Specific characters.—Female: Shell rather short, height about two-thirds the length and higher in the posterior half. Dorsal margin of valve strongly rounded, ventral border less so.

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[1] A contribution from the Zoology Department, University of Maryland, College Park, and the Chesapeake Biological Laboratory, Solomons, Md. Received May 5, 1949.

Posterior end broadly rounded, lower portion with a noticeable flange. Surface of shell covered with shallow pits. Furca with seven claws. Length reaching 3.3 mm. in the female and 2.6 mm. in the male. Length of Tortugas female specimen 1.71 mm.; height 1.06 mm.

Occurrence.—Two females from haul of 30-foot otter trawl in 10–11 fathoms along the east side of White Shoal, August 9, 1930 (stations 49–30); one female from debris of broken-up *Porites* clump brought up by aid of diving hood, west side of Loggerhead Key, July 26, 1930 (station 33-30) (depth not given; may have been 12–15 feet); one female from tow of 30-foot otter trawl in 10–11 fathoms in channel east and south of Loggerhead Key, August 8, 1930 (station 47-30); one female from the debris of cracked-up rock from west side of Loggerhead Key, June 26, 1931 (no station number).

Distribution.—Also known from the Gulf of Naples.

Cypridina flatus, n. sp.

Figs. 15–16

Specific characters.—FEMALE: Valves rather flattened dorsoventrally, dorsal border almost straight, ventral border well rounded. Frontal incisure deep and narrow with a well-defined striated lamella below. Posterior border of the shell with a marked flange on the lower half. Surface of shell smooth and polished. Antennae and other appendages typical of the genus. Furca with nine claws. Length 2.44 mm.; height 1.50 mm.

MALE:—Unknown.

Occurrence.—One female believed to have been taken with 30-foot otter trawl from a depth of 580–600 fathoms about 40 miles south of No. 2 Red Channel Buoy, July 30, 1932 (? station 65-32), holotype (slide), U.S.N.M. no. 88845.

Subfamily ASTEROPINAE

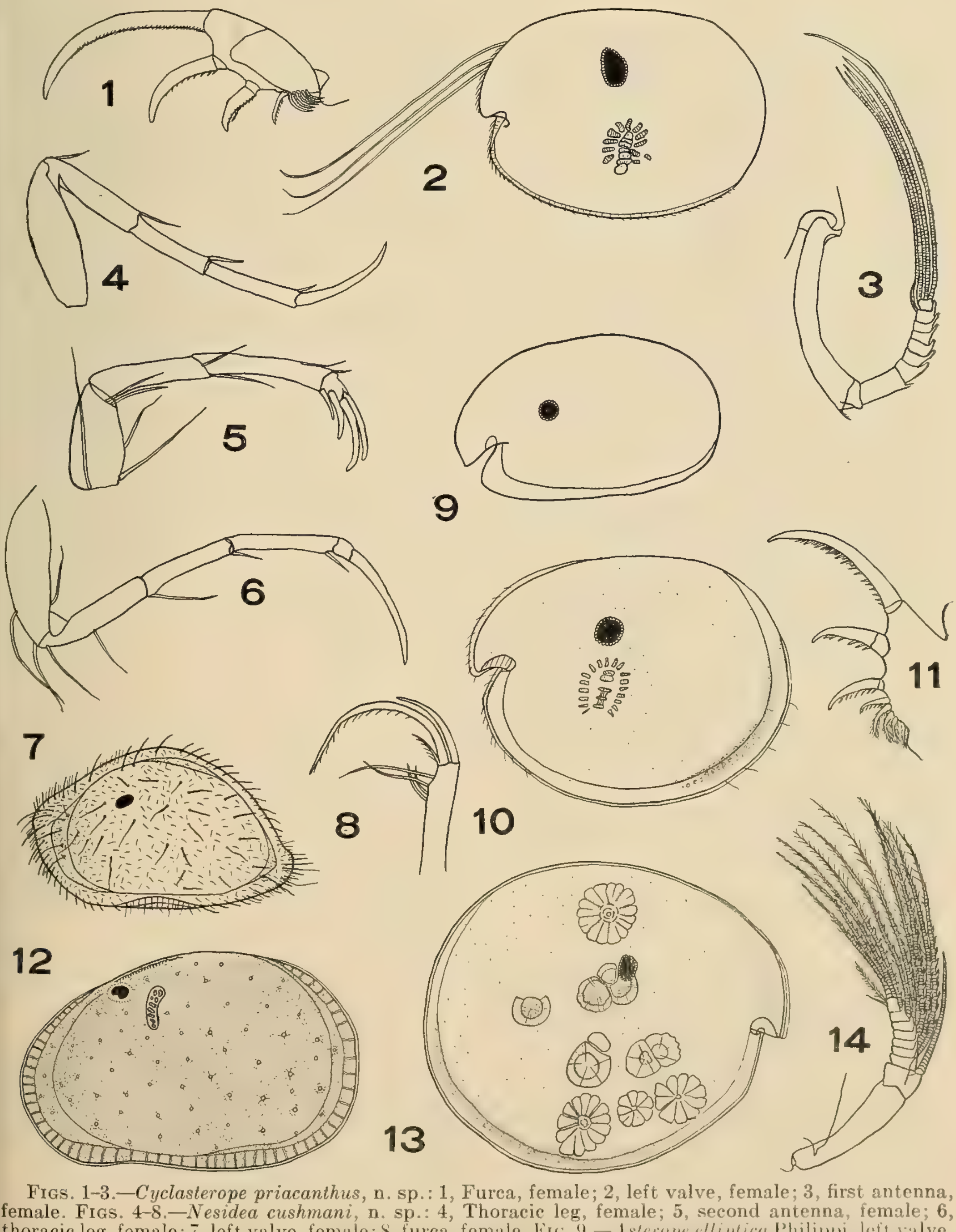
Genus **Asterope** Philippi

Shell more or less oblong in shape, of firm consistency with prominent frontal incisure placed in the lower half of the anterior margin. Sexual dimorphism strongly marked in this genus. Eyes well developed in both sexes. Anterior antenna 6-articulated and similar to that of other members of the Cypridinidae. Furca with at

TABLE 1.—DISTRIBUTION OF SPECIES

Station	Location	Date	Depth	Ostracods
30-30	West side Loggerhead Key	July 24, 1930	12–15 feet	*Asterope elliptica* *Nesidea cushmani*
31-30	East side Loggerhead Key	July 24, 1930	Rocks at low tide	*Cyclasterope tripla*
33-30	West side Loggerhead Key	July 26, 1930	12–15 feet (?)	*Cypridina squamosa* *Nesidea cushmani* *Asterope elliptica*
35-30	13 miles south of No. 2 Red Buoy	July 29, 1930	From stomach of fish, 80–100 fathoms	*Conchoecia atlantica*
47-30	Channel east and south of Loggerhead Key	August 8, 1930	10–11 fathoms	*Cypridina squamosa* *Macrocypris africana* *Pontocypris intermedia* *Nesidea cushmani*
48-30	Lower channel east and south of Loggerhead Key	August 9, 1930	10–11 fathoms	*Nesidea cushmani*
49-30	West side of White Shoal	August 9, 1930	10–11 fathoms	*Cypridina squamosa* *Cyclasterope sphaerica*
12-31	Southwest channel, north of No. 2 Red Buoy	June 26, 1931	9–10 fathoms	*Cyclasterope tripla*
16-31	South side of channel through Bird Key reef	June 30, 1931	*Porites* clumps at low tide	*Asterope elliptica*
65-32	40 miles south of No. 2 Red Buoy	July 30, 1932	580–600 fathoms	*Cypridina flatus*
Loggerhead	Key West side	June 26, 1931	Cracked-up rock	*Cypridina squamosa* *Asterope elliptica* *Asterope mariae* *Cyclasterope sphaerica* *Macrocypris schmitti* *Xestoleberis punctata*
Marker 754	Off Loggerhead Key	June 25, 1931	From stomach of fish, *Priacanthus cruentatus*, taken in gill net	*Cyclasterope priacanthus*

least five claws. This genus is strikingly set off from all the other known ostracods by the presence of seven well-developed gills in the posterior part of the body.



Figs. 1-3.—*Cyclasterope priacanthus*, n. sp.: 1, Furca, female; 2, left valve, female; 3, first antenna, female. Figs. 4-8.—*Nesidea cushmani*, n. sp.: 4, Thoracic leg, female; 5, second antenna, female; 6, thoracic leg, female; 7, left valve, female; 8, furca, female. Fig. 9.—*Asterope elliptica* Philippi, left valve, female. Figs. 10, 11.—*Cyclasterope tripla*, n. sp.: 10, Left valve, female; 11, furca, female. Fig. 12.—*Xestoleberis punctata*, n. sp.: Left valve, female. Figs. 13, 14.—*Cyclasterope sphaerica*, n. sp.: 13, Right valve, female; 14, first antenna, female.

Asterope mariae (Baird)

Fig. 22

Cypridina mariae W. Baird, Proc. Zool. Soc. London **18:** 257. 1850.
Cylindoleberis mariae G. S. Brady, Trans. Linn. Soc. London **26:** 465. 1868.
Asterope oblonga C. Claus, Crust. Syst.: 92. 1876.
Cylindoleberis oblonga G. W. Müller, F. Fl. Neapel **21:** 219. 1894.
Asterope mariae G. O. Sars, Crustacea of Norway **9:** Ostracoda: 17. 1928.

Specific characters.—FEMALE: Shell very narrow and flattened dorsoventrally. Height barely half the length. Both dorsal and ventral shell margins only very slightly curved; both extremities rounded and about equal. Frontal incisure of valves rather deep and narrow, occurring well below the middle of the extremity. Surface of the shell smooth and polished, completely devoid of hairs. Eyes well developed. Last pair of legs provided with only 12 cleaning spines. Caudal furca with 10 claws, the proximal ones very small. Length of adult female reaching 2.20 mm. Length of Tortugas specimen 1.43 mm.; height 0.67 mm.

MALE: Of very different external appearance from female. Shell of irregular, oblong shape, being noticeably higher in the anterior portion than posteriorly. Valves thin and pellucid with a few hairs.

Occurrence.—Two immature females found in the debris of a cracked-up rock from the west side of Loggerhead Key, June 26, 1931 (no station number).

Distribution.—West coast of Sweden, British Isles, coast of France, Mediterranean, Norwegian coast, Vineyard Sound.

Asterope elliptica Philippi

Fig. 9

Asterope elliptica A. Philippi, Arch. Naturg. **61:** 188. 1840.
Asterope elliptica G. O. Sars, Arch. Naturv. Kristian. **12:** 200. 1887.

Specific characters.—FEMALE: Shape of shell similar to *A. mariae* but shorter with definitely rounded dorsal and ventral borders. Height of shell about half the length. The distal border of the fourth segment of the anterior antenna, which is fused with the third segment, is strongly bent, the ventral border being only half as long as the breadth of the segment. The claws at the end of the anterior antenna are longer than the dorsal border of the third to the sixth segments. The exopodite of the mandibular palp is longer than one-half the second segment of the palp. Furca similar to *A. mariae*. Length of female reaching 1.44 mm. Length of Tortugas female 1.09 mm.; height 0.68 mm.

MALE: Shell not as high as that of the female and reaching about six-thirteenths of the body length. Anterior portion somewhat broader than in the female. Dorsal border of the shell abnormally rounded owing to a well-defined corner at the posterior border.

Occurrence.—Two females were obtained from rock fragments brought up with aid of diving hood west side of Loggerhead Key, in 12–15 feet of water, July 24, 1930 (station 30–30); one female from debris of broken up clump of *Porites* also brought up from the west side of Loggerhead Key with aid of diving hood, from probably the same depth as the preceding, July 26, 1930 (station 33-30); two females, also from the debris of broken up *Porites* clumps picked up at low tide on the south side of the channel through Bird Key reef, June 30, 1931 (station 16-31); one female from the debris of cracked-up rock from west side of Loggerhead Key, June 26, 1931 (no station number).

Distribution.—Mediterranean, North Atlantic Ocean.

Genus **Cyclasterope** G. Brady

This genus is closely related to the genus *Asterope* and resembles it closely in many respects. However, it differs from *Asterope* in the arrangement of the claws of the furca. In the present genus there are three or four comparatively short claws followed by a greater number of decidedly smaller, bristlelike structures. Shell height is also much greater than in *Asterope* and many forms are almost spherical in shape.

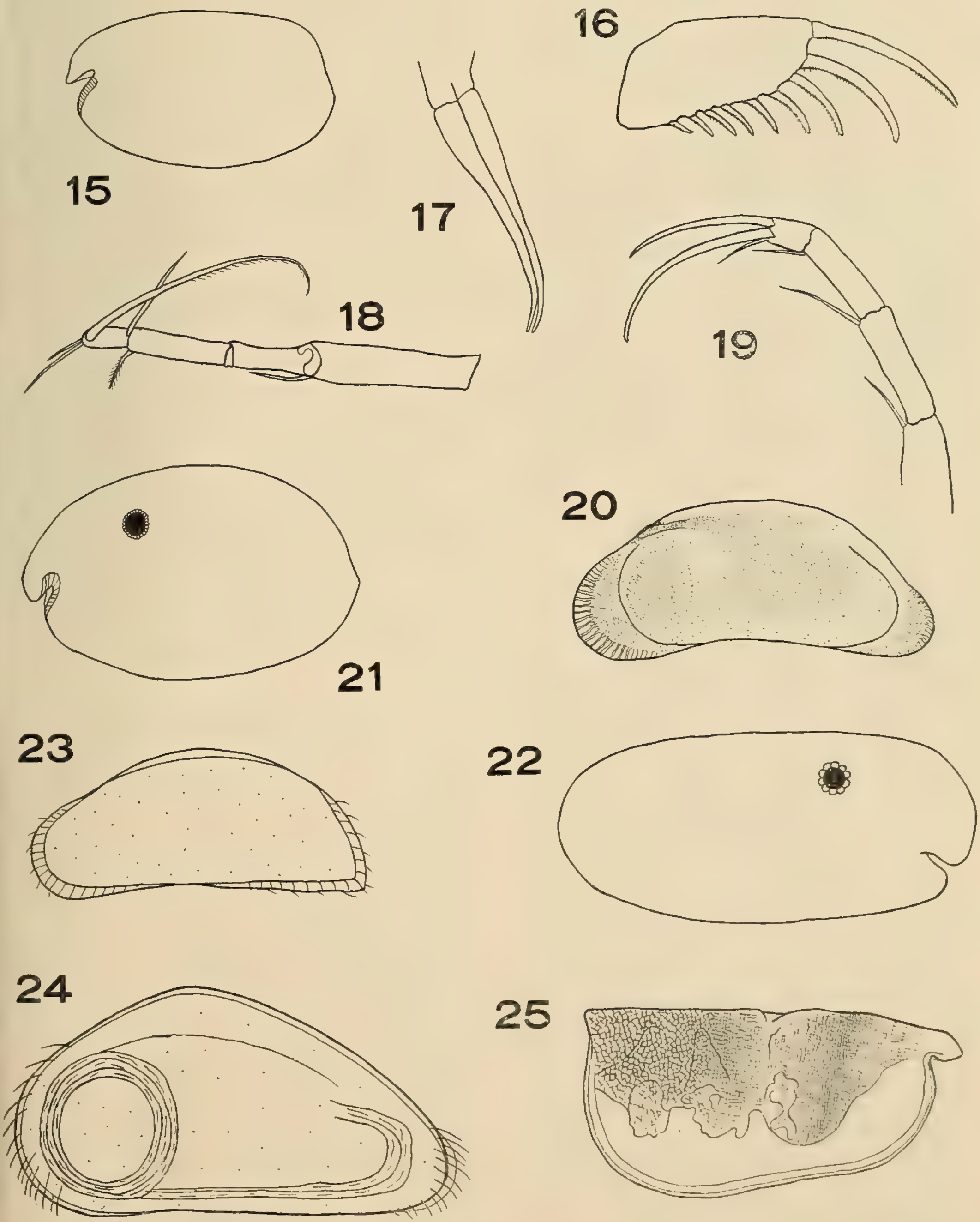
Cyclasterope priacanthus, n. sp.

Figs. 1–3

Specific characters.—FEMALE: Shell broadly oval in outline; height about eight-elevenths length. Ventral border well rounded; dorsal border less rounded with a trace of a corner at the posterior border. Both anterior and posterior extremities well rounded. Eye large and well developed. Muscle markings form a conspicuous rosette in lower center of the shell. On the fifth segment of the anterior antenna there is an absence of teeth. Furca with four main claws and five smaller ones. Length 2.78 mm.; height 2.04 mm.

MALE: Unknown.

Remarks.—The shape of the shell of this species is similar to that of *C. brevis* (G. W. Müller) but



FIGS. 15, 16.—*Cypridina flatus*, n. sp.: 15, Left valve, female; 16, furca, female. FIGS. 17–20.—*Macrocypris schmitti*, n. sp.: 17, Furca, female; 18, second leg, female; 19, first leg, female; 20, left valve, female. FIG. 21.—*Cypridina squamosa* G. W. Müller, left valve, female. FIG. 22.—*Asterope mariae* (Baird), right valve, female. FIG. 23.—*Macrocypris africana* G. W. Müller, left valve, female. FIG. 24.—*Pontocypris intermedia* Brady, left valve, male. FIG. 25.—*Conchoecia atlantica* (Lubbock), right valve, female.

is not so high or so long as *brevis*. The shell of the present species also lacks the branched striations.

Occurrence.—One specimen was found in the stomach of *Priacanthus cruentatus*, which was taken in a gill net off Loggerhead Key, June 25, 1931 (no station number). Holotype (slide), U.S.N.M. no. 88848.

Cyclasterope tripla, n. sp.

Figs. 10–11

Specific characters.—FEMALE: Shell somewhat similar to that of *C. americana* (G. W. Müller) but with a decidedly flattened dorsal margin and a somewhat more prominent and deeper frontal incisure. Ventral border very much rounded and practically spherical in outline. Posterior extremity somewhat more broadly rounded than the anterior. Inner margin of the postero-ventral border with a series of short, parallel markings. Eye large and prominent. Muscle markings very prominent. Appendages typical of the genus. Furca with three large claws and five smaller ones. Length 1.96 mm.; height 1.65 mm.

MALE: Unknown.

Occurrence.—Three females were obtained from seaweed taken at low tide from rocks below the lighthouse dock, east side of Loggerhead Key, July 24, 1930 (station 31-30); holotype (slide), U.S.N.M. no. 88842; one female from haul of 30-foot otter trawl in 9–10 fathoms in the southwest channel north of No. 2 Red Buoy, June 26, 1931 (station 12-31).

Cyclasterope sphaerica, n. sp.

Figs. 13–14

Specific characters.—FEMALE: Shape of shell almost spherical; height slightly greater than five-sixths the length. Dorsal and ventral borders both broadly rounded, the ventral being practically spherical in outline. Frontal incisure very small and shallow. Central portion of the shell covered with a series of rosettelike markings, possibly glands. Eye not so large as in the preceding species but well developed. There are no teeth on the fifth segment of the anterior antenna. The terminal flagellae of the anterior antennae are strongly toothed through the greater part of their length. Furca with three large, powerful claws, followed by seven small ones. Length 2.44 mm.; height 2.12 mm.

MALE: Unknown.

Remarks.—In general appearance this species resembles *C. americana* (G. W. Müller), but the shell is higher and larger and no prominent markings are figured in Müller's drawing. Müller does not figure the eye, but this is probably an omission.

Occurrence.—One female from haul of 30-foot otter trawl in 10–11 fathoms along the east side of White Shoal, August 9, 1930 (station 49-30), holotype (slide), U.S.N.M. no. 88844; one female from the debris of cracked-up rock from west side of Loggerhead Key, June 26, 1931 (no station number).

Family CONCHOECIDAE

Subfamily CONCHOECINAE

Genus **Conchoecia** Dana

This genus contains forms which are unmistakably set off from closely allied ostracods by the oblong shape of the body and the almost straight dorsal margin, which is prolonged anteriorly into a beaklike rostral projection. The surface of the shell is without hairs but is usually covered by delicate, curved striations which cross each other at intervals, forming a network. The genus has been found in almost every part of the oceans and comprises nearly one hundred species.

Conchoecia atlantica (Lubbock)

Fig. 25

Halocypris atlantica J. Lubbock, Trans. Ent. Soc. London, n. s., **4**: 28. 1856.

Conchoecia cuneata G. W. Müller, Zool. Jahrb. (Abt. Syst.) **5**: 271. 1890.

Conchoecia atlantica G. W. Müller, Ergebn. Tiefsee-Exp. **8**: 92. 1906.

Specific characters.—FEMALE: Shell very solidly built and small in proportion to the body so that the valves are always found gaping open. Shell is oblong in shape; height about one-half the length of the body. The depth of the shell is noticeably greater in the posterior half of the body than in the anterior. Dorsal border straight with a marginal indentation halfway toward the anterior extremity. Ventral border well rounded posteriorly and tapering toward the front. Posterior border straight and ending in a blunt spine at the postero-dorsal margin. Length 3.58 mm.; height 1.88 mm.

Male: Shell even more elongate than in the female. Not so much difference in depth of shell in posterior and anterior portions.

Occurrence.—One female was taken from the stomach of a fish caught with 30-foot otter trawl in 80–100 fathoms, about 13 miles south of no. 2 Red Buoy, July 29, 1930 (station 35-30).

Distribution.—Atlantic, Indian, and Pacific Oceans.

Suborder Podocopa

Family CYPRIDAE

Subfamily Pontocyprinae

Genus **Pontocypris** Sars

Shell of rather thin consistency, of triangular shape. Valves unarmed at the edges but are densely hairy. Eye well developed. Members of this genus are active swimmers as is shown by the well-developed natatory antennae. Posterior antenna has a 3-jointed endopodite. The second leg is equipped with a very heavy, terminal claw. In the male, in many species, the spermatic vessels are carried forward along the ventral side and terminate in a dense spiral coil.

Pontocypris intermedia G. Brady

Fig. 24

Pontocypris intermedia G. S. Brady, Ann. Mag. Nat. Hist., ser. 4, **2:** 220. 1868.

Pontocypris intermedia G. O. Sars, Arch. Naturv. Kristian. **12:** 267. 1887.

Pontocypris intermedia G. W. Müller, F. Fl. Neapel **21:** 254. 1894.

Specific characters.—Female: Shell definitely triangular in shape; height about three-eighths the length; highest one-third the distance from the anterior end. Dorsal border peake-shaped with a definite rounded corner at the highest point. Anterior end broadly rounded, posterior end produced by a sloping dorsal margin to an extremity of less than half the depth of the anterior margin. Ventral border nearly flat with only a slight indentation directly below the dorsal peak. Eye large and prominent. Both extremities covered with long, heavy hairs. Length 0.67 mm.; height 0.25 mm.

Male: Shell shape similar. The spermatic vessels are drawn along the ventral margin toward the anterior end where they terminate in a spiral coil. Length 0.64 mm.; height 0.27 mm.

Occurrence.—Five males from haul of 30-foot otter trawl in 10–11 fathoms in channel east and south of Loggerhead Key, August 8, 1930 (station 47-30).

Distribution.—Mediterranean.

Subfamily Macrocyprinae

Genus **Macrocypris** Brady

Shell elongate, tapering toward the posterior end. Consistency of shell very solid, containing much lime. Inner duplicatures of valves rather broad with a striated marginal zone. Dorsal border well rounded; ventral border almost straight. Eye lacking in this genus. First leg terminating with two large claws of unequal length. Second leg with a long backward-directed seta, extended almost to the base of the leg. Caudal furca small and very rudimentary.

Macrocypris africana G. W. Müller

Fig. 23

Macrocypris africana G. W. Müller, D. Südp. Exp. **10:** 97. 1908.

Specific characters.—Female: Shell elongate, height about two-fifths the length, highest point about the middle. Dorsal border strongly arched; ventral border almost straight with a slight curve inward toward the middle. Anterior end somewhat produced and well rounded. Posterior extremity ending in an acuminate corner at the ventroposterior angle. Surface of valves very smooth and polished. Anterior thoracic leg with the shortest claw longer than one half the length of the longer claw. Length 1.22 mm.; height 0.51 mm.

Male: Somewhat smaller than the female but in other respects little different. Furca straighter than in the female.

Occurrence.—Three females from haul of 30-foot otter trawl in 10–11 fathoms in channel east and south of Loggerhead Key, August 8, 1930 (station 47-30).

Distribution.—Originally described from the coast of South Africa.

Macrocypris schmitti, n. sp.

Figs. 17–20

Specific characters.—Female: Shell of a dark brown color and of firm consistency. Height about one-half the length. Dorsal margin strongly arched; ventral margin exhibiting a marked concavity in the center and extending through three-fourths of the length. Anterior end somewhat produced and broadly rounded. Posterior end produced in a well-rounded, tapering extremity, with a steep, concave slope descending from the dorsal margin. Inner duplicatures broad with pore canals evident. Shortest claw of anterior thoracic leg equal to one-half the length of the longer claw. Furca symmetrical with end claws short. Length 1.22 mm.; height 0.60 mm.

MALE: Unknown.

Remarks.—This species seems to most closely resemble *M. turbida* G. W. Müller, as far as shell shape is concerned, but is higher and has a greater concavity in the ventral border. The furcae also differ from those of *M. turbida.*

Occurrence.—Eight females were taken from debris of cracked-up rock from west side of Loggerhead Key, June 26, 1931 (no station number). Holotype (slide), U.S.N.M. no. 88847.

Family NESIDEIDAE

Genus **Nesidea** Costa

Short, high forms with strongly arched dorsal border. The dorsal border forms a more or less prominent angle with the anterior border. From the angle the anterior border slopes posteroventrally. Posterior border with a prominent angle at the ventral corner. Ventral border almost straight in the middle with upward sloping extremities. Posterior margin of the anterior thoracic legs with two bristles. Furca with at least five long bristles.

Nesidea cushmani, n. sp.

Figs. 4–8

Specific characters.—FEMALE: Shell typical for the genus with highly arched dorsal border. Height three-fifths the length; highest point in the middle from which the dorsal margin slopes ventralward anteriorly and posteriorly. Anterior end with an upturned corner about midway. From the corner the anterior border slopes backward to the ventral margin. Posterior extremity produced ventrally in a pronounced corner with concave upward-sloping extremity. Surface of shell covered with a profusion of long, heavy hairs. Eye well developed. Appendages typical for the genus. Furca with the shorter claw about one-half the length of the longer. On the posterior border of the furca are two short and two much longer bristles. A fifth bristle is located at the base of the longer claw.

MALE: Unknown.

Occurrence.—One female was obtained from rock fragments brought up with aid of diving hood west side of Loggerhead Key in 12–15 feet of water, July 24, 1930 (Station 30-30); two females from debris of broken-up clump of *Porites* also brought up from west side of Loggerhead Key with aid of diving hood, from probably the same depth as the preceding, July 26, 1930 (station, 33-30); two females from haul of 30-foot otter trawl in 10–11 fathoms in channel east and south of Loggerhead Key, August 8, 1930 (station 47-30); one female from haul of 30-foot otter trawl in 10–11 fathoms, lower channel east and south of Loggerhead Key, August 9, 1930 (station 48-30); one female from the debris of cracked-up rock from west side of Loggerhead Key, June 26, 1931 (no station number), holotype (slide), U.S.N.M. no. 88843.

Family CYTHERIDAE

Subfamily XESTOLEBERINAE

Genus **Xestoleberis** Sars

Shell tumid, narrowed in front, with the ventral face distinctly flattened behind. Valves slightly unequal with a smooth and polished surface. Eyes distinctly separated and well developed. Behind the eyes is a kidney-shaped spot. Antennae rather short, the anterior ones with the terminal part 4-articulate. Posterior antennae without any evident suture of the penultimate joint, the two apical claws stout. Legs rather short and stout. Caudal lamellae with two short bristles on the tip.

Xestoleberis punctata, n. sp.

Fig. 12

Specific characters.—FEMALE: Shell, seen laterally, subtriangular in shape with greatest height slightly behind the middle and approaching seven-elevenths of the length. Dorsal border strongly arched and rounded; ventral border flattened with a slight concavity in anterior half. Both extremities broadly rounded, the posterior more so than the anterior. Prominent pore canals on anterior, ventral, and posterior borders. Pore canals are not bifurcate at the ends. Two distinct eyes with the characteristic kidney-shaped spot behind them. Teeth on hinge prominent. Surface smooth without hairs but covered with a series of large, porelike spots. Internal structure typical of the genus with no exceptional structures. Length 0.54 mm.; height 0.35 mm.; width 0.28 mm.

Male: Unknown.

Occurrence.—One female from the debris of cracked-up rock from the west side of Loggerhead Key, June 26, 1931 (no station number). Holotype (slide), U. S. N. M. no. 88847.

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PROCEEDINGS OF THE ACADEMY

429th Meeting of Board of Managers

The 429th meeting of the Board of Managers, held in the Cosmos Club, June 13, 1949, was called to order at 8:15 p.m. by the President, F. H. H. Roberts, Jr. Present were: F. B. Silsbee, H. S. Rappleye, N. R. Smith, W. W. Diehl, F. M. Defandorf, W. F. Foshag, C. L. Gazin, F. E. Johnston, F. A. Weiss, S. A. Dayton, R. S. Dill, Margaret Pittman, and F. M. Setzler.

The minutes of the 428th meeting were read and approved.

The President announced that Dr. C. J. Connolly had been appointed on the Committee on Grants-in-Aid for Research, to fill the vacancy caused by the death of Dr. John M. Cooper.

The President read a motion approved by the Executive Committee at its meeting held on June 13, 1949, and recommended it to the Board of Managers. The Board approved the recommendation submitted by the Executive Committee, namely, to instruct the Custodian and Subscription Manager to sign the necessary agreement for storage with Waverly Press, Inc. In collaboration with the Treasurer, the Custodian and Subscription Manager is to work out a plan whereby a proper proportion of existing stock and a suitable average for each issue as it appears be forwarded to the Custodian and Subscription Manager for storage; at the end of each calendar year the stock remaining with Waverly Press, Inc., to be shipped to Washington for storage.

The Secretary read a letter from J. E. Graf, Chairman of the Committee on Policy and Planning, transmitting a report of the Committee and suggesting that discussion of it be deferred until a later meeting of the Board when a full membership could be present. Mimeographed copies of the report were distributed to the members of the Board present, and the Secretary was instructed to send copies also to the members who were not present.

The Secretary announced the following deaths: Alfred P. Dachnowski-Stokes, botanist, formerly with the Department of Agriculture, on May 17, 1949 (elected November 3, 1926); John M. Cooper, anthropologist, Catholic University of America, on May 22, 1949 (elected February 26, 1940).

In the absence of the Custodian and Subscription Manager, it was announced that a complete set of the Journal had been sold to the Library of the Communicable Disease Center, in Georgia, a branch of the U. S. Public Health Service, for $326.

The President reported on the matter of the Science Calendar. He had conferred with James Fulton Fox, President of the D. C. Council of Engineering and Architectural Societies. After some discussion the Board voted that the Academy continue to cooperate with the D. C. Council of Engineering and Architectural Societies to carry on the Science Calendar and that the President of the Academy be authorized to appoint one or more members to represent the Academy on the Science Calendar Committee.

The meeting adjourned at 9:18 P.M.

F. M. SETZLER, *Secretary*

NEW MEMBERS OF THE ACADEMY

There follows a list of persons elected to membership in the Academy, by vote of its Board of Managers, since June 1, 1948, who have since qualified as members in accordance with the bylaws. (See also previous list in the March 15, 1949, issue of JOURNAL.) The bases for election are stated with the names of the new members.

RESIDENT

Elected June 7, 1948

CARL L. LARSON, surgeon, National Institutes of Health, in recognition of his researches on brucellosis and virus diseases.

WILLIAM J. SVIRBELY, chemist, University of Maryland, in recognition of his researches in physical chemistry and in particular his work with respect to dipole moments and reaction kinetics.

Elected October 18, 1948

DAVID H. JOHNSON, mammalogist, United States National Museum, in recognition of his work in mammalogy, particularly in the systematics of rodents.

Elected December 13, 1948

PHILIP H. ABELSON, physicist, Department of Terrestrial Magnetism, Carnegie Institution of Washington, in recognition of his contribution to nuclear physics (co-discoverer of Neptunism) and for his work on separation of isotopes by thermal diffusion.

ARSHAM AMIRIKIAN, engineer, Bureau of Yards and Docks, Navy Department, in recognition of his development of an improved method of analysis and its application to the design of shore structures and auxiliary floating craft for the Navy and his invention and development of a new construction technique utilizing thin-wall cells of precast reinforced concrete.

WALLACE R. BRODE, chemist, National Bureau of Standards, in recognition of his contributions to chemistry, particularly in chemical spectroscopy and the relation between absorption spectra and chemical constitution.

DAVID H. DUNKLE, paleontologist, United States National Museum, in recognition of his contributions in the field of vertebrate paleontology, particularly for his work on fossil fishes.

JEROME B. GREEN, physicist, Naval Ordnance Laboratory, in recognition of his special researches in spectroscopy.

ALFRED R. LOEBLICH, JR., paleontologist, United States National Museum, in recognition of his contributions in the field of micropaleontology, particularly for his work on the Foraminifera.

J. HOWARD MCMILLEN, physicist, Naval Ordnance Laboratory, in recognition of his contributions to hydrodynamics, particularly with reference to water-entry phenomena.

MAX M. MUNK, physicist, Naval Ordnance Laboratory, in recognition of his theoretical work in aerodynamics.

PAUL F. NEMENYI, engineer, Naval Ordnance Laboratory, in recognition of his contributions to theoretical engineering with particular emphasis on fluid dynamics.

DAVID NICOL, paleontologist, United States National Museum, in recognition of his studies of fossil Lamellibranchiata.

RICHARD B. ROBERTS, physicist, Department of Terrestrial Magnetism, Carnegie Institution of Washington, in recognition of his contributions to nuclear physics, naval ordnance, and biophysics.

LYNN H. RUMBAUGH, physicist, Naval Ordnance Laboratory, in recognition of his oceanographic researches, particularly with reference to Naval Ordnance applications.

DONALD C. SMITH, chemist, Naval Research Laboratory, in recognition of his contributions in the field of chemical spectroscopy, particularly the application of molecular spectra (infrared, Raman, and ultraviolet) to the study of chemical problems.

ALAN T. WATERMAN, physicist, Office of Naval Research, in recognition of his contributions to the electrical properties of solids and his promotion of applied and basic research.

ROYAL WELLER, physicist, Naval Ordnance Laboratory, in recognition of his contributions to the field of applied physics, notably in photoelasticity.

Elected February 14, 1949

ALLEN V. ASTIN, physicist, National Bureau of Standards, in recognition of his contributions to physics, including investigations on the theory of dielectrics and the organization of researches on problems in ordnance, especially on proximity fuzes and guided missiles.

Fred Keller, Jr., geophysicist, United States Coast and Geodetic Survey, in recognition of his services to the science of geophysics in the fields of terrestrial magnetism and airborne magnetic surveying.

William Vogt, conservationist, Pan American Union, in recognition of his outstanding contribution to conservation, especially in Latin America.

Elected April 18, 1949

Robert F. Bacher, physicist, Atomic Energy Commission, in recognition of his research in atomic physics and nuclear physics and his administrative ability and leadership shown in his nationally important position.

Frank A. Biberstein, Jr., engineer, Catholic University of America, in recognition of his experimental work in elastic and plastic behavior of thick tubes.

Thomas McP. Brown, medicine, George Washington University, in recognition of his outstanding work in medical bacteriology.

A. A. Dutilly, naturalist, Catholic University of America, in recognition of his exploration of the Canadian Arctic, Alaska, and Greenland; plant collections from the Arctic; and collections of insects, rocks, and minerals.

Richard M. Fraps, physiologist, Bureau of Animal Industry, in recognition of his researches on the mechanism of ovulation in birds, in particular the demonstration of the presence of progesterone.

A. Szent-Györgyi, biochemist, National Institutes of Health, in recognition of his work on the structure of vitamines and of the behavior of muscles.

John C. Hubbard, physicist, Catholic University of America, in recognition of his work in ultrasonics.

Mary Juhn, physiologist, University of Maryland, in recognition of her researches on the production of feathers and on plumage patterns.

Fred L. Soper, medicine, Pan American Sanitary Bureau, in recognition of his outstanding accomplishments in the field of public health in the Tropics; especially in the control of hookworm and yellow fever in South America, and in the elimination of *Anopheles gambiae* from northeast Brazil and certain areas of Egypt.

F. Leo Talbott, physicist, Catholic University of America, in recognition of his contribution to the proximity fuze and his work in nuclear physics.

Alfred Weissler, chemist, Naval Research Laboratory, in recognition of his work in analytical and physical chemistry with special reference for his researches on ultrasonics in chemistry.

Elected June 13, 1949

Marion Maclean Davis, chemist, National Bureau of Standards, in recognition of her contributions to physical-organic chemistry, in particular her researches on acid-base reactions in organic solvents.

Samuel G. Lasky, geologist, United States Geological Survey, in recognition of his contributions to the geology and origin of ore deposits and to the knowledge of our national mineral resources.

Alfred T. Myers, chemist, United States Geological Survey, in recognition of his contributions to analytical chemistry by means of the flame photometer and the spectrograph.

V. T. Stringfield, geologist, United States Geological Survey, in recognition of his outstanding contributions to the science of ground-water hydrology.

NONRESIDENT

Elected December 13, 1948

Karl M. Silberschmidt, plant physiologist, Instituto Biologico, São Paulo, Brazil, in recognition of his investigations on the interrelations of stock and scion with respect to resistance and tolerance to virus infection, and of his share in standardizing the methods of virus research.

Elected April 18, 1949

John R. Bowman, chemist, Mellon Institute of Industrial Research, Pittsburgh, Pa., in recognition of his contributions to the physical sciences, and in particular researches in petroleum chemistry.

CORRECTION

Gordon W. McBride, consultant chemical engineer, was erroneously listed as chemist, U. S. Department of Agriculture, in the March 15, 1949, issue of the Journal.

Obituaries

Bailey Willis, one of the founders of the Washington Academy of Sciences, died at Palo Alto, Calif., on February 19, 1949, at the age of 91. He was a past-president of the Geological Society of America and of the Seismological Society of America, a member of the National Academy of Sciences, was assistant in geology to the director of the U. S. Geological Survey, 1897–1901, and at his deathwa s professor emeritus of Stanford University. He was awarded a gold medal by the Geological Society of France in 1910, was decorated Commander Order of Leopold II by the Government of Belgium in 1933 and received the Belgian Legion of Honor in 1936, and was honored by the Geological Society of America in 1944 by the presentation of the Penrose medal. He was a member of many American geologic, seismologic, and geographic societies, and of several English, German, and Belgian geologic societies.

Willis was born at Idlewild, Cornwall-on-the-Hudson, N. Y., the son of the poet Nathaniel Parker Willis, from whom he inherited his ability to write clearly and speak fluently. He was graduated from Columbia School of Mines, receiving the degree of Mechanical Engineer in 1878 and of Civil Engineer in 1879. He entered the services of the United States Government in 1879 as special agent for the Tenth Census for the study of coals in the Northwest, in connection with the construction of the Northern Pacific Railroad. He was next engaged as geologist by the Transcontinental Survey, 1881–84. He received an honorary degree of doctor of philosophy from the University of Berlin, Germany, in 1910 and the degree of doctor of science from Columbia University in 1929. He lectured in geology for a time at Johns Hopkins University and at the University of Chicago.

Willis joined the staff of the U. S. Geological Survey as geologist in 1884, and, as editor of Geologic Maps of the Survey, made a critical study of methods of printing geological maps in colors. With the cooperation of S. J. Kubel, chief engraver and lithographer of the Survey, he mixed the primary pigments—red, blue, and yellow—obtaining secondary and tertiary combinations, and perfected a color scheme of tertiary colors for sedimentary rocks which ranged in prismatic order from reddish brown for the older rocks through purple, blue, green, to yellow-brown for the younger rocks. Igneous rocks, printed in bright primary and secondary colors, constrasted sharply with the duller tertiary colors of the sedimentary rocks. This color scheme has become standard for colored geologic maps in the United States and in some other countries and is regarded as one of Willis's chief contributions to the science. He actively advocated its adoption for world maps, and as United States delegate he presented it at a meeting of the International Committee on World Maps in London in 1909, where it was favorably received.

In his early days on the Survey, Willis confined his geologic researches to the structure of the Appalachians. For the study of folds produced by controlled pressure, he constructed a working model which consisted of an elongated box in which were placed layers of various composition and thickness, simulating the bedded sedimentary rocks of the Appalachians. These layers were compressed by a piston at one end, which produced folds at right angles to the pressure similar to those seen in nature. From a study of these folds and the associated faults, he deduced certain laws, and his conclusions included the observation that certain thick and resistant layers acted as competent beds that transmitted the stress and localized folds and faults. The summary of the results obtained from this model, recorded in *Mechanics of Appalachian structures*, published in 1893, is classic in geologic literature. In the construction of the model little attention was paid to the nonlayered basement rocks beneath the bedded sedimentary rocks, and Willis failed to note at this time, but commented on later, the production of shearing stresses in these more-or-less homogeneous rocks which resulted in shear planes approximately at angles of 45° with the direction of pressure, and movement of the blocks thus produced localized folds and thrust faults in the overlying bedded layers. Willis observed the physiography of the surface features of the Appalachians and summarized the physiography in a popular treatise entitled *The Northern Appalachians* in a monograph of the National Geographic Society. Later he mapped areas in the Cascade Mountains and Puget Sound region for the Geologic Atlas of the United States. His work for the Survey culminated in the compilation and printing of the Geologic Map of North America, the first edition of which was published for the meeting in Washington of the International Geologic Congress in 1906. It was finally published with complete descriptive text in 1911. While still on the Geological Survey staff Willis went to China in 1902 for the Carnegie Institution of Washington to search for fossils, chiefly Cambrian, and collect other geologic data, and in 1911 he went to Patagonia as consulting engineer for the Argentina Government. These investigations and studies led to several reports and scientific and descriptive papers.

Willis was appointed professor of geology at Stanford University in 1915, and was retired as emeritus professor in 1922, but resumed teaching at the university to enlisted men and officers during World War II. He was popular with the students and hailed them on the campus in a friendly manner. He became deeply interested in the study of earthquakes, so prevalent in California, and applied his engineering knowledge to a solution of the problem of building structures resistant to earthquakes. In the laboratory of Stanford University he constructed structures of various types and composed of different building materials, which were subjected to external shock simulating earthquake effects. He showed how earthquake damage could be reduced to a minimum, and his conclusions became the basis for many of the requirements in the California building code. His views on earthquakes, their remedies, and their prediction were much sought by California newspapers and the public generally. In the investigation of earthquakes for the Carnegie Institution, he went to Chile in 1923, to the Orient, Palestine, and Cyprus in 1927, to East Africa in 1929, and to Japan, the Philippines, and India in 1937.

After retirement from active duty at the university in 1922, Willis devoted more time to the study of observations he had made in his travels, and he wrote voluminous papers expounding his theories. Besides many papers on seismological subjects, including the Santa Barbara earthquake, the San Andreas rift, and the compilation of fault maps of California, he discussed the structure of the Coast Ranges, Pacific Ranges, and the Rocky Mountains. His conclusions differed so radically from those of others that they lead to many controversies. In his verbal arguments, Willis always maintained a calm, smiling, and courteous bearing, and apparently enjoyed the discussion. He wrote papers on Continental Drift, Isostacy, and the African Plateau and Rift Valleys of Africa and Asia. Rift valleys, or graben, were interpreted by Willis as largely the result of compressive stresses acting as ramps or up-thrusts. He applied this theory to the uplift of the Sierras in California, which precipitated further controversy. In his presidential address before the Geological Society of America in 1929, entitled *Continental genesis*, he speculated on the composition and structure of the interior of the earth, and expounded what might be called the blister theory of localized melting of magmas. In later papers—*Asthenolith* (*melting spot*) *theory* and *Eruptivity and mountain building* (with his son Robin Willis)—he theorized that local melting of the rocks in the asthenosphere was due to the effect of radioactive disintegration.

Among Willis's popular descriptive articles and books may be mentioned *Research in China*, *Living Africa*, *Earthquakes in the Holy Land*, and *A Yanqui in Patagonia*. Before his death he had completed *Friendly China*, which is about to come from the press. Willis devoted much of his spare time to landscape painting. He was a collector of Japanese and Chinese art, which he housed in an artistic cabinet built by himself. He was always physically vigorous and athletic, a strenuous walker and bicycle rider. In 1882 he married Miss Altona Holstein Grinnell, who died in 1896. In 1898 he married Miss Margaret Delight Baker, who died in 1941. His children, who survive him, are Mrs. Hope Willis Rathbun, Mrs. Margaret Willis Smith, Cornelius Grinnell Willis, and Robin Willis. Both sons are oil geologists.

George W. Stose.

Charles Whitman Cross, internationally known geologist and rose grower, died on April 20, 1949, at the age of 94 years. He had been ill for several years in the Chestnut Lodge Sanatorium in Rockville, Md.

Dr. Cross was born in Amherst, Mass., on September 1, 1854. His father was Moses Kimball Cross, who served as a Congregational minister in Iowa, and his mother was Maria (Mason) Cross. Dr. Cross graduated from Amherst College in 1875 and continued his graduate studies in Germany. He was at Göttingen during 1877 and received his Ph.D. degree from the University of Leipzig in 1880. On his return to this country he was appointed as "geologic and microscopical assistant" on the Geological Survey. In July 1880 he was assigned to the Division of the Rocky Mountains in Denver, where S. F. Emmons was in charge. His first field work was a study of the Ten Mile District coalfield near Denver and was done in cooperation with W. F. Hillebrand as chemist. This work led to a study of the zeolite minerals in the basalt of Table Mountain; and the results were published as the first paper (American Journal of Science) of these two outstanding scientists. This was followed immediately by another joint paper on the minerals of the Pikes Peak area. Thus began Dr. Cross's lifelong interest in the geology, particularly the igneous rocks, of the Rocky Mountain region. A very large proportion of his long list of published papers is on some phase of the geology of Colorado. Much of his time was devoted to a detailed study of the San Juan region of southern Colorado, which is characterized by an immense and complex series of Tertiary volcanic rocks. After his retirement, this work was carried forward by Esper S. Larsen, Jr., who had long been associated with Dr. Cross in the study of that region. In 1915 Dr. Cross headed a committee appointed by the National Research Council to report on the slides in the Panama Canal; and the report submitted to President Wilson was an important factor in the measures which brought them under control.

In 1902 Dr. Cross began a study which led to the publication of a report on the petrology of the Hawaiian Islands. He was chief of the section of petrology of the U. S. Geological Survey from 1903 to 1907 and the secretary of the Survey's committee of petrographic names. This and his own work made the classification of igneous rocks a matter of major interest to him. Dr. Cross, Joseph P. Iddings, Louis V. Pirsson, and Henry S. Washington collaborated on devising a system for their classification, and in 1902 (Journal of Geology) they proposed "a quantitative chemico-mineralogical classification and nomenclature of igneous rocks," followed a year later by a 268-page volume on the subject. This, commonly known as the CIPW system, introduced an entirely new method of rock classification which was widely adopted and profoundly influenced the geologic thought of the world.

After his retirement in 1925, Dr. Cross became interested in the cultivation and breeding of roses, and characteristically he applied the same rigorous scientific methods to his avocation that he had so long applied to his profession. His garden at 101 E. Kirke Street, Chevy Chase, with over 2,000 rose bushes, became one of the show places of Washington. His rose-breeding experiments produced outstanding new roses as "Chevy Chase," "Hon. Lady Lindsay," and "Mrs. Whitman Cross."

Dr. Whitman Cross was a member of the National Academy of Sciences (treasurer 1911–1919); the American Philosophical Society; the Geological Society of America (president in 1918); the National Research Council, 1918–1922 (treasurer, 1918–1919; vice chairman, Division of Geology and Geography, 1918); the Geological Society of Washington (president 1899); honorary member of Colorado Scientific Society; the Washington Academy of Sciences; a foreign member of the Geological Society of London; honorary corresponding member of Academy of Natural Sciences of Philadelphia; the Literary Society of Washington; and the Potomac Rose Society. He was associate in petrology, Smithsonian Institution, an honorary position he had held since 1920.

At the time of his death Dr. Cross was the oldest living member of the National Academy of Sciences and the oldest alumnus of Amherst College, from which he received the honorary degree of doctor of science in 1925.

Dr. Cross is survived by Mrs. Cross (nee Virginia Stevens), a son, Richard Stevens Cross, of Philadelphia, and two grandchildren, Charles Whitman Cross and Helen Virginia Cross.

Clarence S. Ross.

Alfred Paul Dachnowski-Stokes was born on January 23, 1875, in Königshütte, Germany, and passed away on May 18, 1949, at Riverside, Calif. He attended Höhere Knabenschule, Breslau, Germany, then the University of Berlin (1900–01), and studied at the University of Vienna, Austria (1901–02). He came to America and beginning in 1903 was a student at the University of Michigan, from which he received his doctorate in 1906. While at Michigan he was also an instructor in plant physiology. The next year, 1906–07, saw him as professor of biology and chemistry at the Michigan Military Academy, Orchard Lake, Mich. Following this, for seven years, he was assistant professor of botany at Ohio State University during a part of which period he was also a collaborator with the U. S. Bureau of Plant Industry and with the Geological Survey of Ohio in cooperation with the U. S. Bureau of Mines.

On March 1, 1915, he was appointed scientist in soil laboratory investigations in the Bureau of Soils, U. S. Department of Agriculture. Later, on July 1 of that year, he was transferred to the Bureau of Plant Industry as physiologist in peat investigations. He continued in this capacity as physiologist with special emphasis on peat investigations in the department until his retirement on September 30, 1942. Following his retirement he continued to act as collaborator with the department.

During the years Dr. Stokes built up an enviable reputation as a principal authority on the peat deposits of the United States, particularly on their use for agricultural amendments and for industrial purposes. He traveled rather extensively in Europe as well as in continental United States and Alaska. He was a prolific writer and is the author of many Department of Agriculture bulletins and articles appearing in various scientific journals. His principal contributions were a system of classification of peat materials and a record of the stratigraphy of the various types of vegetation that make up the principal bodies of organic deposits in this country. Dr. Stokes's advice was sought by his fellow workers in the Bureau of Plant Industry and the Bureau of Mines, and by private individuals both in agriculture and industry. He often appeared before the Federal Trade Commission as a witness regarding the character of various commercial products derived from organic deposits.

Dr. Stokes was a member of Sigma Xi, the Botanical Society of America, and the Ecological Society and was a Fellow of the American Association for the Advancement of Science. He leaves a wife and two sons.

J. Kenneth Ableiter.

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SCIENCE EDUCATION.—*Establishment of graduate study courses at the National Bureau of Standards.*[1] HARVEY L. CURTIS.

The first graduate study courses given at the National Bureau of Standards began about October 1, 1908. Every year since then at least three courses have been given. During the 1948–49 year, eight courses were given outside official hours for the primary purpose of enabling employees to present them to some university as credit toward an advanced degree. Moreover, other Government agencies have established similar courses, in all cases making use of the pioneer work at the Bureau of Standards. Because of this wide interest, it seems desirable to record some of the experiences of those who were instrumental in getting this work under way. Because so much of the material to be given depends on the author's memory, the article is presented as a personal narrative.

It is my belief that the graduate study courses were the brain child of Dr. S. W. Stratton, first director of the Bureau of Standards, although there is no record or even tradition of the early development of the idea of such courses. The oldest information concerning Dr. Stratton's idea of establishing such courses is my remembrance of a conversation with him in July 1907 in which he gave expression of the underlying principles of the courses. I had been offered a position at the Bureau, but before accepting I came to Washington to investigate the desirability of so doing. I had a conference with Dr. Stratton in which he outlined the plan of having graduate courses at the Bureau and of permitting the use of official research work as material for a thesis. The plan appealed to me, and the possibility of obtaining a doctor's degree by means of it was an important incentive in bringing me to the Bureau.

I feel sure that Dr. Stratton, before that time, discussed the subject of graduate courses not only with members of his own staff but also with some of the leaders in collegiate physics. The only member of his staff who is now known to have taken an active interest was Dr. E. B. Rosa, chief physicist of the Bureau, who insisted that the work be on a high plane and who conducted one of the early courses. Many of the leaders in collegiate physics came to the Bureau every spring after 1906 to meetings of the American Physical Society. Some of the regular attendants were Ames of Johns Hopkins, Webster of Clark, Millikan of Chicago, Nichols and Merritt of Cornell, and D. C. Miller of Case School of Applied Science. From later developments I think that Dr. Stratton received encouragement at least from Ames and Webster. Doubtless many with whom he talked were opposed to the idea. In support of this, I recall a letter received in the summer of 1908 by one of the junior members of the staff, who wrote to a university where he had been a student to inquire if work done in Bureau courses would be accepted there as credit toward an advanced degree. Not only was the reply most emphatically negative, but the writer proceeded to denounce the whole project, saying that in his estimation it was merely a plan to sell degrees. This letter, which has now disappeared, was seen by only two or three of the staff, all juniors, and was considered by them as "top secret." Nevertheless, by 1907 Dr. Stratton had received enough encouragement to believe the plan was workable.

Before graduate courses were established some universities had accepted research work done at the Bureau as a basis for a Ph.D. thesis, although all instructional work

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[1] Received July 22, 1949.

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was taken at the university. In this way, E. P. Hyde received his Ph.D. degree from Johns Hopkins University in 1906, C. W. Burrows from the University of Michigan in 1907, and F. W. Grover from George Washington University in 1907. The first written evidence that I can find concerning the establishment of graduate courses is a letter to me dated February 27, 1908, from Professor Carhart of the University of Michigan. I quote it in full:

> MY DEAR CURTIS:
>
> At a recent meeting of the Graduate Council, of which I am a member, I was instructed to write to you in relation to your recent letter of inquiry, and to ask you to give us information as soon as you can relative to Dr. Stratton's plan for a year's work at the Bureau of Standards toward the Doctor's degree. At the same time the Council wished it understood that it is prepared to consider such a plan favorably.
>
> The Council was uncertain as to how much is to be included in the year's work. It is clear that the work on a thesis may be done, but how will the other work necessarily going on with the thesis work be superintended?
>
> Please give me any information you may have, or can obtain as soon as convenient.
>
> Very truly yours,
> HENRY S. CARHART.

I do not have a copy of the letter I wrote to Professor Carhart and to which the above refers. It was probably written in January 1908. I replied to the above on March 6, saying that at the moment plans were too indefinite to furnish the information desired but that I would write again as soon as plans were completed.

This favorable letter, and perhaps others, stimulated the activities of the junior members of the staff of the Bureau of Standards. A meeting was held and the "Association for Graduate Study" organized, with the following officers elected: President, H. L. Curtis; secretary-treasurer, R. Y. Ferner[2]; members of the executive committee, P. G. Agnew[3] and E. C. McKelvy.[2]

The principal purpose of the association was to prod Dr. Stratton so that the plan would get under way while the members were still young. Unfortunately, the early records of this association seem to have been lost.

During the spring and summer of 1908 the officers of the association frequently discussed with Dr. Stratton the organization of suitable courses. He proposed the plan of having a 3-year cycle in physics and in mathematics, a procedure still followed after 40 years. The cycle for chemistry was developed later. It was decided that the initial courses would be differential equations, theoretical mechanics, and thermodynamics, the last being included primarily for the benefit of the chemists. Dr. Stratton suggested suitable men as instructors, but the making of all financial arrangements and the fixing of the hours of meeting were turned over to the association, which was composed entirely of those seeking advanced degrees. Dr. A. F. Zahm was selected for theoretical mechanics and Dr. Edgar Buckingham for thermodynamics. Some difficulty was experienced in securing a suitable Washington man to teach differential equations. Just before leaving in September 1908 to attend the London Electrical Conference, Dr. Stratton authorized me to go to Johns Hopkins University (at my own expense) to secure an instructor in differential equations. At his suggestion I conferred with Dr. J. S. Ames, professor of physics, and was able to obtain Dr. J. A. Anderson. He was an excellent instructor and continued to teach courses here for several years. The association fixed the fees at $25 for a course lasting 30 weeks with two hours of instruction a week, the option being given of paying $15 at the beginning of the year and executing a note for the remainder, payable at the beginning of the second semester. The association attempted to make the fees such that the total return would be a maximum.

As soon as definite courses had been arranged, all junior members of the Bureau staff were canvassed to see whether the courses would be supported. The response was much better than had been expected. Men who had taken no previous interest signed up for one or two courses. It was evident before the first lecture was given that there would be a surplus at the end of the year. When Dr. Stratton returned from Europe late in October he was delighted to find the courses under way. The instruction was of high caliber, and the interest of students was good. The only contemporary description of that work that I have found is an undated letter I wrote to Professor Carhart during the fall of 1908:

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[2] Deceased.

[3] Now with the American Standards Association.

> DEAR SIR:
>
> Last February I had some correspondence with you concerning a plan for finishing my work for a doctor's degree by work taken here at the Bureau of Standards. I then wrote you that at that time it was impossible to give details, but that I would supply them when the work was satisfactorily organized.
>
> The work began the first week in October, and is to continue for thirty weeks. For this year four courses are arranged:
>
> (1) Differential Equations, by Dr. Anderson, instructor in Johns Hopkins University.
> (2) Thermodynamics, by Dr. Buckingham, author of Buckingham's "Thermodynamics," and a member of the Bureau Staff.
> (3) Dynamics, by Dr. Zahm, formerly of the Catholic University. In this we are using Webster's "The Dynamics of Particles and of Rigid, Elastic, and Fluid Bodies."
> (4) Laboratory work in Electrical Measurements under the direction of Dr. Rosa.
>
> I am taking courses (3) and (4) and will describe these more in detail. In Dynamics we meet Dr. Zahm for two lectures per week. Besides this we have organized quiz sections and are meeting twice each week for a careful discussion of the text. In the Electrical Measurements a group of three meets for at least four hours of laboratory work per week outside of our regular work. We are also preparing note-books covering the work.
>
> For next year I expect to be able to take courses in the Mathematical Theory of Electricity and in Advanced Mathematics. Dr. Rosa has also expressed a willingness to superintend my thesis, provided that would be acceptable to you.
>
> I would request that you convey this plan to the Graduate Council, and inform me if it meets their approval. In case any further information is desired, I will supply it to the best of my ability.
>
> Yours truly,
> H. L. CURTIS.

This letter had been written with the approval of Dr. Stratton, who had made it clear from the first that each student must make his own arrangements for having the work accredited at the university of his choice. The interest in the work continued throughout the year.

From the beginning, the juniors wanted a senior committee to supervise the work. They realized that only with such a committee could they hope to get their work recognized by a university. Hence it was with satisfaction that the juniors learned that a committee had been appointed by the director "to prepare regulations governing the conditions under which graduate work may be given at the Bureau of Standards, including such questions as the method of selecting courses and instructors; methods of collecting and disbursement of funds; the granting of credits; and such other questions as may seem desirable to include in a set of rules and regulations governing the work in question." The committee consisted of Drs. Stratton, Rosa, Hillebrand, Wolff, Waidner, Burgess, Dorsey, Nutting, Waters, Mr. Fisher, and all instructors. The first meeting was held on March 18, 1909, with all members present except two instructors, Drs. Anderson and Zahm, and with the president of the Association for Graduate Studies as a nonvoting guest. The committee held two additional meetings, adopted a plan, and adjourned sine die. If my memory serves me correctly, this committee did not function very harmoniously. I am quite sure that some parts of the plan they adopted have never been put into effect.

The plan provided for a Board of Graduate Instruction, which met for the first time on April 15, 1909. At this meeting Dr. Stratton appointed an executive committee of nine members, with the juniors represented by two members—Curtis and Dickinson. I find no record of a subsequent meeting of the board.

There was some friction concerning the transfer of the money that the juniors had collected to the new organization. I believe that all salaries for the first year were paid by the juniors and that then the surplus was transferred to the new senior treasurer, Mr. Fisher. A report on the first year's work was made by the association to the executive committee of the board.

One feature of the first year's work that has not been repeated at the Bureau was an experimental course in electrical measurements. This was under the supervision of Dr. Rosa, but as he was in Europe during the fall months the work was carried on by the three students. They were fortunately located, Dellinger in the Resistance and Electromotive Force Section, Curtis in the Inductance and Capacity Section, and Agnew in the Electrical Instruments Section. Meetings were one evening a week and lasted from

5 P.M. until the experiment was finished. At least two of the notebooks are still in existence and have occasionally been consulted in the past 40 years. Starting in January 1909 Dr. Rosa gave lectures on advanced electrical measurements, devoting special attention to the methods of computing inductance. These were attended by several who did not participate in the experimental work. It seems to me to be unfortunate that more experimental courses have not been organized.

The method of deciding on courses and instructors for 1909–10 is obscure. The records of the executive committee for that year are lost, and no one seems to remember details. The courses in physics and mathematics were those outlined in my letter (quoted above) to Professor Carhart, which was written before the executive committee was organized. It was natural that Anderson should be asked to continue as an instructor, since he had made an exceptional reputation in the first year. I am of the opinion that the seniors selected Dr. Dorsey to teach electricity and magnetism, and Dr. Kanolt to teach physical chemistry.

Dickinson and I retired from the student organization at the close of the 1909–10 year as both of us received our Ph.D.'s in June 1910. I can not determine who were our successors. Apparently the executive committee took complete control at the beginning of the 1910–11 year. A procedure was gradually worked out that is satisfactory to students and to the executive committee and that is recognized by a number of universities. It is now known as the National Bureau of Standards Graduate School. Several similar graduate schools are now in operation in the various agencies of the United States Government in Washington and vicinity. They are as follows, with the year in which they were established and the number of courses given in 1948:

Department of Agriculture Graduate School, started in September 1921 and now giving 61 courses;
Naval Ordnance Laboratory Graduate Training Program, organized in September 1944 and offering 10 courses;
Naval Research Laboratory Scientific Training Program, begun in September 1944, now with 21 courses;
David Taylor Model Basin Graduate Program, initiated in February 1946, now giving 3 courses;
The Bureau of Ships Graduate Study Program, started in September 1946 and now having 12 courses;
Fort Belvoir Branch of the Catholic University of America at the U. S. Army Engineering Center, organized in September 1947 with 12 courses.

The number of courses given in the preceding list was largely obtained by counting the courses listed in the Scientific Personnel Bulletin. Only about half the courses listed are graduate courses, but all are given outside official hours. Their primary purpose is to aid in getting advanced degrees.

It is a matter of satisfaction to have had a part in starting so useful a movement. I believe that Dr. Stratton conceived the idea but that he received relatively little encouragement from the senior members of his staff. It would have been a failure but for the support of university men like Ames, Webster, and Carhart. Ames was most helpful. He induced one of his best instructors to come to Washington to give courses and recognized the work as the equivalent of that done on his own campus. He encouraged the use of research at the Bureau as material for doctoral theses. Later, when he was stationed in Washington during World War I, he taught graduate courses at the Bureau of Standards and for one year was chairman of the Graduate Study Committee. He once said to me that it was foolish for the universities to refuse to accept a thesis from the Bureau as there was not one of them where the experimental facilities were so complete or the supervision so critical.

Carhart set the machinery in motion by which I obtained my degree at Michigan, even though many faculty members opposed the innovation. Webster was sympathetic. I recall that Dr. Stratton induced him to lecture to a hastily called meeting of the class in dynamics when he chanced to visit the Bureau. Also Dickinson obtained his degree at Clark University using some of the work done at the Bureau. There was encouragement by other university men, but I do not remember specific names or instances.

The graduate instruction at the Bureau and in other Government agencies may be considered as one phase of the demand for making educational facilities more widespread. This demand has been growing for a century or more, starting with elementary grades and extending to the higher fields. The graduate programs in Government agencies fill a need for those who wish to progress to the top of our educational system but who for financial or other reasons can not take the work in a regular educational institution.

ANTHROPOLOGY.—*The last bison drives of the Blackfoot Indians.*[1] JOHN C. EWERS, U. S. National Museum.

At the height of their power, before the middle of the nineteenth century, the three Blackfoot tribes (Piegan, Blood, and North Blackfoot) and their culturally related allies, the Gros Ventre and Sarsi, laid claim to a vast area of grassland immediately east of the Rocky Mountains, extending from the North Saskatchewan River in present Alberta southward to present Yellowstone Park. At its greatest eastward extension Blackfoot territory reached the mouth of Milk River on the Missouri.

That this region formerly was a well-stocked bison hunting ground is proved not only by the testimony of early white explorers and traders on the great abundance of bison in the area, but also by the large number of remains of old bison-drive sites still observable in the region. A bison-drive site generally is now recognized by low piles of rocks placed at intervals of several feet in two lines extending for hundreds of yards over flat or gently rolling plains in a great V shape, converging at the top of a cliff. At the base of the cliff, under soil and talus accumulations is a bed of bison bones. At such sites groups of Indian hunters working in cooperation lured and/or drove herds of bison into the stone-bordered funnels and over the cliffs to destruction in the valleys below. These sites have been variously referred to as "drives," "pounds," "parks," "traps," "falls," and "kills." The Blackfoot Indians term such a site "piskun," which Grinnell (1892, p. 228) translated "deep-blood-kettle."

Although the existence of a number of these sites has been known to anthropologists for many years, no comprehensive effort has been made to locate and enumerate all such sites within the former Blackfoot territory. With the exception of two sites in the valley of the Yellowstone River near the town of Emigrant in Park County, Mont., partially excavated by Dr. Barnum Brown, of the American Museum of Natural History, and briefly reported by him in an article in Natural History Magazine in 1932, none of the bison-drive sites of this area has been systematically explored by scientifically trained persons. However, the sites have attracted many relic hunters, both Indian and white, searching for arrowheads. Some sites also have been despoiled by enterprising individuals, who have used both hand and power equipment to gather bison bones for sale to commercial fertilizer manufacturers. A few seriously interested amateur archeologists have dug into the bone pits. One of them, the late H. P. Lewis, of Conrad, Mont., located some 24 bison-drive sites in the neighborhood of the Sun, Madison, Teton, and Marias Rivers and their tributaries in Montana. Yet Mr. Lewis himself recognized that he had recorded only a portion of the total number of these sites remaining within the area of his search. (Lewis, MS.)

Stone arrowheads of a variety of sizes, shapes, and materials are the artifacts most commonly found at these sites. Mr. Lewis was impressed by the fact that he had found no objects of metal and no materials suggesting Indian contact with the horse in the bone beds. The findings of the relic hunters and bone collectors appear to have been similar to those of Mr. Lewis. During 3½ years' residence within the area, at Browning, Mont., we heard only one vague and doubtful claim that trade materials (a few blue beads) had been found in a bone bed at

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[1] Received July 18, 1949.

a bison-drive site. The apparent absence of metal arrowheads or other objects of white manufacture in these sites has caused local enthusiasts to look upon them as prehistoric and possibly of considerable antiquity.

That projectile points of Folsom, Yuma, and other apparently early types have been found in association with extinct as well as modern bison species at other sites on or near the western portion of the plains to the southeast of the region under consideration is well known. However, Dr. Brown said of the bison drive sites near Emigrant, "There is no evidence of great antiquity in this discovery for the Bison were the living species, but the form of the arrows indicated that they were not made by the Indians who inhabited that region at the time of white settlement. Several implements were found by other people on the camp sites, among them a steatite bowl (found and owned by the proprietor of the Wanagen Store, a few miles from the buffalo jumpoff site). Such vessels were used by the Shoshone Indians, but not by the Blackfoot tribe who recently inhabited this region. The arrows were probably not more than two or three hundred years old" (Brown, 1932, p. 81). Obviously the age of each bison-drive site within the former Blackfoot area must be determined on its own merits after careful investigation by trained and experienced archeologists.

Dr. Brown's statement that an artifact of Shoshonean type was found in the vicinity of the Emigrant buffalo drives may have particular significance. Other tribes than the Blackfoot and their allies are known to have hunted bison in the area under consideration both before and during Blackfoot occupancy. The Blackfoot tribes probably did not move southwestward from the present province of Saskatchewan into this area until the middle or late eighteenth century (Thompson, 1916, p. 348). Prior to the Blackfoot push into the area it was held by the Kutenai, Salish (Flathead and Pend d'Oreille), and Shoshone (ibid., pp. 327–328; Teit, 1930, pp. 303–307). As late as 1800 the southern boundary of Blackfoot territory extended but a few miles below the present Montana-Alberta boundary (Thompson, 1916, pp. 345–346; Wissler, 1910, p. 12). The Salishan tribes as well as the Kutenai and Nez Percé dwelling west of the mountains continued to cross the Rockies on periodic bison-hunting excursions into the area claimed by the Blackfoot until bison were exterminated in that region.

What few ethnological data have been obtained from those tribes regarding their use of bison drives are somewhat contradictory and largely negative. We have found no contemporary description of the use of bison drives by any of those tribes. Lemhi Shoshone informants stated in 1906 that the Blackfoot method of driving a herd down a ledge was unknown to their people (Lowie, 1908, p. 185). Teit (1930, pp. 103, 347) obtained information to the effect that the Flathead and Coeur d'Alêne formerly stampeded bison over cliffs, but he could not determine whether they used that hunting method before the advent of the horse. Turney-High's Flathead informants denied that their ancestors drove bison over cliffs or into pounds (Turney-High, 1937, p. 115). The modern Kutenai denied that members of that tribe drove bison over cliffs in the period before the acquisition of horses, even though that method was mentioned in tribal folklore (Turney-High, 1941, p. 36).

The use of buffalo drives by the Blackfoot tribes and their allies, on the other hand, can be proved by numerous references in the literature, some of them from the writings of firsthand observers. Blackfoot use of drives can be traced through the historic period until a relatively short time before the extermination of the bison in their territory. Our field notes, based on the testimony of elderly Indians on the Blackfeet Reservation in Montana, obtained within the past decade, help to establish the terminal dates of the use of bison drives by the Blackfoot.

The earliest historic reference to the use of bison drives by the tribes of the northwestern plains appears in the Journal of Mathew Cocking, a Hudson's Bay Company trader, who visited a Gros Ventre "beast pound" in the western part of the present province of Saskatchewan in the fall of 1772. He described this pound as "a circle fenced round with trees laid one upon another, at the foot of an Hill about 7 feet high & an hundred yards in Circumference; the entrance on the Hill-side where the Animals can easily go over; but when in, cannot return: From this entrance small sticks are laid on each side like a fence, in form of an angle extending from the pound; beyond these to about 1½ mile distant. Buffalo dung, or old roots are laid in heaps, in the same direction as the fence: This pound was made by our Archithinue friends last spring, who had great success, Many Skulls & Bones lying in the pound." Although Cocking spent a month and a half near this pound, during which numerous attempts were made to drive bison into it, both by members of his party and by some 28 lodges of Gros Ventre, very few animals were driven into the corral. On December 6, he reported, "no success in pounding; the Strangers say the season is past" (Cocking, 1908, pp. 109–113).

On their journey up the Missouri across the present Montana in the spring of 1805, the Lewis and Clark party observed a drive site of different character on the north side of the Missouri between the mouths of the Musselshell and Marias Rivers. Under date of May 29, 1805, Captain Lewis reported, "Today we passed on the Star'd side the remains of a vast many mangled carcases of Buffalow which had been driven over a precipice of 120 feet by the Indians & perished; the water appeared to have washed away a part of this immence pile of slaughter and still there remained the fragments of at least a hundred carcases, they created a most horrid stench" (Lewis and Clark, 1904, vol. 2, pt. 1, p. 94).

The fur trader Alexander Henry visited a North Blackfoot "pound" at the elbow of the Vermilion River in present Alberta, December 20–22, 1809. He did not describe the construction of that pound but commented upon the mangled carcasses left in it from a previous drive. "The bulls were mostly entire, none but the good cows having been cut up." During his stay at the site the Indians were unsuccessful in luring buffalo into the pound, giving as the reason for their failure that the wind was from the wrong direction and the "smell of the smoke from the camps turned buffalo back before they approached, as soon as they scented the smoke." Yet the day after Henry left the site he received word that he had "scarcely left when a large herd was brought in" (Henry and Thompson, 1897, pp. 576–7).

Writing of the Piegan in 1811, the same author stated, "In winter . . . they disperse in small camps of 10 to 20 tents, make pounds for buffalo, and hunt wolves and kits. . . . So much do these people abhor work that, to avoid the trouble of making proper pounds, they seek some precipice along the bank of the river, to which they extend their ranks and drive the buffalo over it. If not killed or entirely disabled from the fall, the animals are generally so much bruised as to be easily dispatched with the bow and arrow" (ibid., pp. 723–25).

While at Fort McKenzie on the Missouri in the fall of 1833, Prince Maximilian of Wied was told by the Blackfoot of their methods of hunting bison "for which they make in the winter season, large parks into which they are driven" (Maximilian, 1906, vol. 23, p. 108).

When writing of the bison during his visit to Fort Union on the upper Missouri in 1843, the naturalist Audubon stated, "The animal is pounded, especially by the Gros Ventres, Black Feet and Assiniboins" (Audubon, vol. 2, pp. 145–146). This is the last contemporary mention of the practice by the Blackfoot and their allies. When Edwin T. Denig described the use of bison pounds by the Assiniboin in 1854, he said, "We know of no nation now except the Assiniboin and Cree who practice it, because all the rest are well supplied with horses that can catch the buffalo, therefore, they are not compelled to resort to these means to entrap them" (Denig, 1930, p. 532). When Lieutenant Bradley wrote briefly of Blackfoot bison hunting in the mid-seventies he used the past tense in referring to this method. "The usual manner of hunting buffalo was by making pens at the edge of a precipice and driving the animals over, sometimes killing them by hundreds and even thousands. The Indians were very expert in driving them long distances by means of mounted warriors" (Bradley, 1923, p. 256).

The most complete descriptions of Blackfoot use of the piskun were based upon the testimony of informants obtained by George Bird Grinnell (1892, pp. 228–232) and Clark Wissler (1910, pp. 34–38) after bison were exterminated. Grinnell distinguished three types of piskun, each adopted to a particular hunting terrain. The North Blackfoot, who hunted to a considerable extent on relatively level ground, built their piskun like that of the Cree Indians in the form of a corral with rising timbered causeway leading up to the entrance of the corral from which there was a sheer drop of about 4 feet into the corral. The Piegan and Blood, living in more broken country nearer the mountains, drove the bison over cliffs. If the cliff was not a high one they built a corral at its base to prevent the animals' escape. But if the cliff was of sufficient height to insure the death or serious injury of the bison as result of their fall, no corral was necessary.

The descriptions previously quoted indicate that in historic times, after they obtained horses, the Blackfoot employed the piskun primarily late in fall and early in winter. At that season the Blackfoot tribes were divided into hunting bands comprising small fractions of the total tribal populations, engaged in collecting adequate supplies of meat for subsistence through the prolonged winter of snow and ice and bitter cold. In the Blackfoot country the severe winter period usually does not begin until the last week of December or early in January. The dated references to the use of drives in the early contemporary accounts of Cocking and Henry refer to its employment no later than December. Cocking was told on December 6 that the season for pounding was already past. This seems to confirm the testimony of Piegan informants to S. A. Barrett that "the Indians had certain spots where the fixed winter camps were established in the fall of the year. At this season the buffalo were fat and prime and the drives to secure a winter's food supply were usually held immediately after this fixed camp was established" (Barrett, 1922, p. 23).

The survival of the use of the piskun among the Piegan can be dated with considerable accuracy. Grinnell stated that in 1892 "many men were still living who have seen the buffalo driven over the cliff." He estimated that "the piskun was in use up to within thirty five or forty years ago" among the Piegan (Grinnell, 1892, p. 230). That would have been until about 1852–1857. Wissler (1910, p. 36) said that none of the Piegan informants who described the use of the piskun to him had taken part in a drive. However, Barrett found in 1921 that "two of the oldest men on the reservation claimed that they had themselves, when very young men, participated in buffalo drives" (Barrett, 1922, p. 27). In 1943 there was no Piegan living on the Blackfeet Reservation in Montana who had witnessed a buffalo drive. Nevertheless, the story of the destruction of the last Piegan piskun was known to a number of the older Indians. The following account of this event was obtained from Lazy Boy (born about 1855; died 1948) in 1943. At that time Lazy Boy was the oldest member of the Piegan tribe.

> This happened when I was a baby. My father told me about it, and I have heard the story many times since from the old people.
>
> The Piegan band called Never Laughs was camped on the Teton River a few miles north of the present town of Choteau. Their chief announced, "Now we are going to make a buffalo fall." They built a corral below the cliff and piled rocks in a great V shape on the slope above the fall. They chose the man who was to lead the buffalo to the fall. But each time he lured them in between the lines of rocks they broke away before they reached the cliff edge. After this had happened three times, young Many Tail Feathers became angry. That night he made a fire and burned the corral.
>
> That same night a war party started from camp. Many Tail Feathers followed it. When he caught up with the war party the leader told him, "You go back home. Everybody is against you because you burned the corral."
>
> Many Tail Feathers returned to the Teton River, to Harm Hill. He slept on top of it that night seeking a vision, but no dream came to him. A second night he slept there. In his dream he saw two young boys coming toward him. They asked him, "Are you the man who saved all the women and children?" He answered, "Yes." As the two boys walked away he saw them turn into buffalo. On the third night he saw in his dream a group of people, men, women, and children, dancing toward him. Their leader wore a handsome red war bonnet. When he came near, the leader asked, "Are you the man who saved all the buffalo by tearing up the corral?" Many Tail Feathers replied, "Yes." Then the leader said, "We are the buffalo. For saving all our men, women and children we thank you. I give you my bonnet—the red war bonnet." The group turned

away. Before they disappeared they turned into buffalo. Two scabby bulls, running behind the rest, turned back and gave Many Tail Feathers their power too.

After Many Tail Feathers returned to camp he set about collecting material to make up the bonnet he had been given in his dream. Every bird gave him one of his feathers to put on the bonnet. It was a straight-up bonnet, decorated with weasel hides, red flannel and brass tacks as well as feathers. It looked so pretty all the men wanted it. But Many Tail Feathers kept it for his own. He wore it to war many times before he transferred it to another man.

Many Tail Feathers, the son of the second chief of the Never Laughs band, was a young man at the time he burned the corral near Choteau. He had a fine war record. According to Richard Sanderville he died about 1888. His red war bonnet, one of the most respected sacred headdresses of the Piegan, was transferred to another Piegan before the end of intertribal warfare. It proved unlucky to its later wearers. One owner was killed by the Crow while wearing it, and the enemy took the bonnet from his head. The bonnet was remade by the dead man's father and brother, Calf Tail. Calf Tail was accidentally killed while hunting buffalo, and the bonnet was buried with him. Still later in the nineteenth century the bonnet was again remade. This bonnet is now in the collections of the Museum of the Plains Indians, Browning, Mont. (catalog no. 176). Doubtless the interest of the Piegan in the origin and history of the sacred red war bonnet has helped to fix in their memory the last bison drive of their tribe.

Elderly Piegan informants acknowledged that the North Blackfoot of Canada continued to make use of the piskun for a number of years after the Piegan abandoned it. During the summer of 1947, Weasel Tail, an aged Blood Indian, then living on the Blackfeet Reservation in Montana, related his own experiences as a participant in these later bison drives. His account is of value for its detailed description of the drive as well as for the light it sheds on the survival of piskun use among the Canadian Blackfoot:

Twice I have seen buffalo corralled. The first time I was a small boy about four years old. We were camped near the North Piegan in the Porcupine Hills west of the present town of Macleod (Alberta). I don't remember anything about it except that I saw the dead buffalo in the corral and that I fell over one of the pointed stakes projecting into the corral and cut a bad gash in my forehead just over my right eye. You can still see the scar.

The second time I was about 15 years old. I killed one of the buffalo in that corral with a gun. I remember it well.

I was then among the North Blackfoot near present Gleichen (Alberta). It was in winter. We didn't drive the buffalo over a cliff. We built a corral near the edge of timber toward the bottom of a downhill slope. We made the corral of cottonwood posts set upright in the ground to a height of about 7 feet, and connected by crosspoles of cottonwood or birch tied to the posts with rawhide ropes. All around the corral stakes of cottonwood or birch were laid over the lowest crosspoles. Their butt ends were firmly braced in the ground outside the corral. Their other ends projected about 3 feet or more inside the corral at an angle so that the ends were about the height of a buffalo's body. These ends were sharpened to points, so that if the buffalo tried to break through the corral, after they had been driven into it, they would be impaled on the stakes. From the open side of the corral the fence of poles extended in two wings outward and up the hill. These lines were further extended by piles of cut willows in the shape of little lodges tied together at the tops. These piles were about half as high as a man and were spaced at intervals of several feet. On the hill just above the opening of the corral a number of poles were placed on the ground crosswise of the slope and parallel to each other. The buffalo had to cross these poles to enter the corral. These poles were covered with manure and water which froze and became slippery so that once the buffalo were in the corral they couldn't escape by climbing back up the hill.

Before the drive began a beaver bundle owner handled the sacred buffalo stones in his bundle and prayed. He sang a song, "Give me one head of buffalo or more. Help me to fall the buffalo."

Then the men of the camp rode out on horseback, got around behind a herd of buffalo and drove it toward the corral. A man stood at the top of the hill and gave a signal to the women and children, who were hiding behind the willow piles, when the buffalo were coming. As the buffalo passed them the women and children ran out from their hiding places.

Once inside the corral, the buffalo were killed by men and boys with guns. I believe we killed 33 buffalo that time. Then the camp chief went into the corral to take charge of the butchering and division of the meat. While butchering in the corral the people ate buffalo liver, kidneys, and slices of brisket raw. Two young men took kidneys, liver, brisket, tripe, and manifold to the beaver bundle owner who had prayed for the success of the fall and who had remained in his lodge. Each man who had killed a buffalo in the corral was given its hide and ribs. Then the rest was cut into quarters and the chief divided the quarters among the families in the camp. Each family got the same share, whether the family was large or small. After the buffalo were divided the corral was broken up for fire wood.

I have never heard of a buffalo corral made by any of the Blackfoot tribes since the time of this fall in which I participated. Of course we had plenty of guns then. There were already less buffalo than there had been. We could hunt them on horseback.

Since Weasel Tail, born about 1857, was about 15 years of age at the time of this event, we can date the last bison drive of the Blackfoot at about the year 1872. This was a full century after Mathew Cocking's first description of the use of the piskun by Indians of the northwestern plains. It was only a decade before the bison was exterminated in the Blackfoot country.

In the use of bison drives by the Blackfoot tribes we observe the survival of traditional, prehistoric bison-hunting techniques among the historic peoples. Undoubtedly the drive was devised in prehistoric times as a method of cooperative hunting by pedestrian Indians armed with bows and arrows and/or lances which were most effective at short range. After the Blackfoot acquired firearms and horses in the eighteenth century they possessed more efficient and sure means of killing bison. Nevertheless, they rarely used guns in hunting bison on horseback. They employed the surround and individual chase on horseback in bison hunting during the spring and summer seasons. However, all the Blackfoot tribes continued to make use of the traditional drives in collecting their winter meat supply late in fall. The Piegan abandoned the use of drives in the middle of the nineteenth century. The North Blackfoot, poorest in horses of the three Blackfoot tribes, continued to employ drives until bison were nearly exterminated in their territory.

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PALEONTOLOGY.—*The hinge and marginal pectinations of* Nuculoidea opima (*Hall*), *type of* Nuculoidea *Williams and Breger.*[1] H. E. VOKES, The Johns Hopkins University.

When Williams and Breger proposed the term *Nuculoidea* for "Nucula-like shells" that "possess characters which place them in an intermediate position between Dall's family ?*Ctenodonta* [sic] and Adams' family embracing the later and recent Nuculidae" (1916, p. 173) they specifically mentioned the fact that internal molds of "*Nucula opima* Hall = *Nucula randalli* Hall and authors," the species they designated as the genotype, "show distinctly a well-developed cartilage pit under the umbones." They make no mention of other hinge characters, however, and the presumption is that no specimens showing the hinge were available to them. Further, with respect to the species they describe and refer to their new "subgenus," they specifically add that the hinge features are unknown (op. cit., pp. 175, 177).

So far as I have been able to determine as a result of a hasty check of the literature, no previous or subsequent author has figured or discussed the hinge and internal characters of the genotype species. When, therefore, curatorial work on the collections of The Johns Hopkins University revealed, among several typically bivalved specimens from the "Hamilton Group, Pratt's Falls, New York," a single right valve embedded in a rather soft, dark-gray shaly matrix, advantage was taken of the opportunity of preparing it to the extent of exposing the hinge and inner margins. The nature of the specimen made it seem unwise to attempt to remove it entirely from the matrix, and it was, therefore, not possible to examine the impressions of the musculature. Since, however, this has been described by Williams and Breger from molds (op. cit., p. 173) this omission is not of serious importance.

DESCRIPTION OF THE SPECIMEN

The exterior characteristics of the species are well known and have been several times figured, the latest being in the Shimer and Shrock *Index fossils of North America* (1944, pl. 145, fig. 22). The Pratts Falls specimens show that there is considerable variation in general proportion, with the average tending to be somewhat relatively longer in proportion to the height than the form shown by Shimer and Shrock. The umbos, situated slightly behind the posterior third of the length, are relatively high, with the beaks being direct to very slightly prosogyrate, and have a rather sharp umbonal ridge curving from their anterior side toward the anterior end, but dying out before reaching the shell margin. The ornamentation consists of relatively coarse concentric ridges.

Hinge characters.—The dentition is typically nuculoid in character, with anterior and posterior rows of taxodont teeth separated by a chondrophore. In contrast to most other nuculids, however, the posterior row is only slightly shorter than the anterior. The posterior tooth row is straight, confined to the posterior dorsal margin of the valve, and contains eleven relatively narrow, transverse teeth. The anterior five of these are dorsal to the chondrophore, and are separated by very narrow sockets indicating thin, lamellar teeth in the corresponding position of the left valve. The posterior teeth in this row are separated by sockets essentially as wide as the teeth themselves. The anterior tooth row is straight, except for the posterior end which narrows and curves upward dorsal to the chondrophore. This row has 12 teeth that are heaviest anteriorly and become progressively thinner posteriorly. The anterior tooth is essentially a strong pustule, the next three teeth posterior to this show a slight tendency to be chevron-shaped, the remaining ones are straight and transverse, with the three most posteriorly located teeth being greatly reduced in size above the chondrophore.

The chondrophore itself is broadly triangular, narrower than the tooth rows and, therefore, not projecting. It is the triangular shape of this chondrophore that results in both the anterior and posterior tooth rows passing dorsally above it, with consequent reduction of the teeth themselves. In most genera of the Nuculidae the chondrophore is spoon-shaped, and projects anteriorly, with the result that only the anterior tooth row tends to pass above it with consequent reduction in width and in the size of the teeth born upon it. The only other nuculid forms with

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[1] Received June 20, 1949.

a triangular chondrophore are the peculiar little Recent *Brevinucula* Theile, 1934 (monotype, *Nucula* (*Brevinucula*) *guineensis* Theile) and *Nuculopsis* Girty, 1911 (type, *Nucula ventricosa* Hall, 1858 (not Hinds, 1843) = *Nuculopsis girtyi* Schenck (1934, p. 30), a Pennsylvanian species). In this form, as figured by Girty (1915, pl. 15, figs. 6, 7) and by Schenck (1934, pl. 2, fig. 19) the chondrophore is wide, broader than the tooth rows, and projects into the cavity of the valve; the anterior teeth are all markedly chevron-shaped, including those that are dorsal to the chondrophore, while the few posterior teeth present are straight. None of these latter are, however, indicated as occupying a position dorsal to the chondrophore itself.

In *Brevinucula* there are no teeth dorsal to the chondrophore, which projects but slightly into the interior of the valve.

Characteristics of the inner margins of the valve.—Williams and Breger, apparently on the basis of the examination of the internal molds available to them, considered this to be smooth and made it the most important character in their distinction of the "subgenus" *Nuculoidea* from *Nucula* s.s. They state (1916, pp. 173–174):

> The Paleozoic nuculoid shells mentioned above agree with Nucula in general outline, configuration, pearly shell, and taxodontic hinge, as well as in having a cartilage pit. . . . However, one of the characters commonly associated with Nucula is the denticulate ventral margin on the interior of the shell. This denticulate or pectinate margin is developed in all the Recent and Tertiary species of Nucula examined by me and Mr. Breger, comprising several dozen species, as well as in several Cretaceous forms. On the other hand, the Paleozoic shells otherwise identifiable with Nucula lack the denticulations on the interior along the ventral margin. We have not discovered a single specimen from the Ordovician, Silurian, Devonian or Mississippian which possesses the denticulate ventral margin, except the little *Nucula shumardiana* Hall, from the Mississippian Spergen limestone of Indiana. Doubtful appearances of a crenulate margin in this tiny species have been observed on some specimens from Spergen Hill. This species appears, however, even externally, to be more nearly related to the recent *Nucula pernula*[2] than to the other Paleozoic Nuculas. The persistent absence of the denticulate margin in the early and frequently large Nuculas and its persistent development in the Recent Nuculas furnish a ready and easy distinction. The non-denticulate and earlier form is here designated Nuculoidea, from its resemblance to Nucula.

In view of these remarks it occasioned considerable surprise during the course of the preparation of the present specimen to find that the inner margins were not smooth, as claimed by Williams and Breger, but were actually marked by the presence of long, closely parallel, microscopic striations that gave a distinctly pectinate appearance under the microscope. These striations are so fine as to be observable with difficulty without magnification and would probably be quickly lost through weathering on any natural internal mold, such as was available to Williams and Breger. The striations are present on the anterior, ventral, and posterior internal margins of the valves; they are separated by interspaces approximately twice the width of the striation, and the area of the valve margin marked by their presence is approximately 15 times the width of the interspaces.

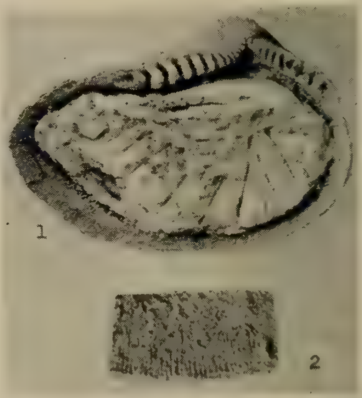

FIG. 1.—View of the interior of specimen of *Nuculoidea opima* (Hall) from Pratts Falls, N. Y., × 2. FIG. 2.—Enlarged view of portion of anterior ventral margin outlined in Fig. 1, showing the nature of the marginal denticulations or pectinations, × 7½.

The occurrence of this structure was so unexpected that a second preparation was made from a bivalved specimen from Pompey, N. Y., which was enclosed in a brownish-buff, calcareous, shaly matrix. The hinge structures were not so well preserved, but the characteristic internal striations were equally developed. This would seem to confirm their presence as a definite character of the species, and not as a result of the vagaries of preservation of the form.

It is difficult to assess the significance of this character. The presence or absence of denticulations on the inner margins of the valves has been used by many authors as a means of subdividing genera of the Nuculidae. The first to do so appears to have been Defrance, in 1825, the latest seems to have been Schenck (1934), who proposes the following classification:

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[2] "*Arca*" *pernula* Müller, type of *Nuculana* Link, 1807, family Nuculanidae.

(A) Forms with denticulate ventral margins:
    (1) *Nucula* Lamarck, 1799
    (2) *Pronucula* Hedley, 1902
    (3) *Pectinucula* Quenstedt, 1930
    (4) *Linucula* Marwick, 1931
(B) Forms with smooth inner ventral margins:
    (5) *Nuculoma* Cossmann, 1907
    (6) *Nuculopsis* Girty, 1911
    (7) *Nuculoidea* Williams and Breger, 1916
    (8) "*Nuculopsis*" Woodring, 1925
    (9) *Leionucula* Quenstedt, 1930
    (10) *Palaeonucula* Quenstedt, 1930
    (11) *Ennucula* Iredale, 1931
    (12) *Brevinucula* Theile, 1934
(C) Forms with divaricate sculpture:
    (13) *Acila* H. and A. Adams, 1858
    (14) *Truncacila* Schenck, *in* Grant and Gale, 1931
(D) Systematic position uncertain:
    (15) *Deminucula* Iredale, 1931
    (16) *Protonucula* Cotton, 1930
    (17) *Nucula tuberculata* Gabb, 1873

Cox (1940, pp. 10–11) has taken exception to the use of denticulations, stating:

> One difference between the Jurassic and earlier forms and the Recent genotype of *Nucula* lies in the absence of the internal marginal denticulations which characterize that species. Such denticulations are not, however, present in all the Recent species, some of which have completely smooth margins, while others (*N. obliqua* Lamarck, *N. expansa* Reeve, *N. superba* Hedley), smooth margined to the naked eye, may be seen under a lens to have very finely denticulate margins. The denticulation of the margins appears, therefore, to be a matter of degree and not a clear basis for generic separation. The complete absence of denticulations in the earlier fossil forms is, however, significant.

The significance of this argument is somewhat impaired, however, when it is realized that all three of the species mentioned specifically are representatives of *Ennucula* Iredale, 1931, the first, "*Nucula*" *obliqua* Lamarck, being the type of the subgenus. This group was differentiated from *Nucula* s.s., in part on hinge characters, as well as on the supposed absence of denticulations. It would seem, however, that on the basis of these microscopic denticulations, the subgenus *Ennucula* must be transferred from Schenck's group B (above) to his group A. The final sentence in the quotation given above serves, however, to emphasize the unique nature of the marginal pectination observed in *Nuculoidea opima*, and together with the nature of the hinge, and especially of the chondrophore, to stress the generic entity of *Nuculoidea*. This genus, too, must be removed from Schenck's group B, but in view of the difference between the pectinate structure developed by the striations, and the typical denticulate structure present in *Nucula* s.s., it would seem to require the recognition of a separate group for its reception.

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BOTANY.—Muhlenbergia minutissima (*Steud.*) *Swallen and its allies*.[1] CHARLOTTE GOODDING REEDER,[2] Osborn Botanical Laboratory, Yale University. (Communicated by JASON R. SWALLEN.)

Critical study of the annual species of *Muhlenbergia* has revealed the need for several changes in synonymy, as well as the desirability of describing a new species in this large and complex genus. These changes are presented in this paper.

Recently Swallen published the results of his study of the "Awnless Annual Species of *Muhlenbergia*" (Contr. U. S. Nat. Herb. **29**: 203–208. 1947). From the material that in the North American Flora (**17**(7): 485–486. 1937) was treated as only four species (of

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[1] Received July 28, 1949.

[2] I am indebted to Dr. Frank Gould, of the University of Arizona Herbarium (ARIZ), and to Dr. H. A. Gleason, head curator of the New York Botanical Garden (NY), who kindly lent material

Sporobolus), Swallen has recognized eight species, two of which he described as new. In so doing, he segregated *Muhlenbergia minutissima* (Steud.) Swallen as a distinct species, adding at the end the remark (op. cit., p. 208): "Typically, the lemma is quite awnless, but occasionally there is a very short awn or mucro, indicating a relationship with *M. texana* and a transition from the awnless to the awned species of *Muhlenbergia*." Since *M. texana* Buckl. was not included in his discussion or key, attempts to find means of distinguishing it from *M. minutissima* led to a detailed study of it and its close allies.

With his brief description of *Muhlenbergia texana*, Buckley (Proc. Acad. Nat. Sci. Philadelphia 1862: 90. 1862) cited no specimen, simply stating: "Northern Texas. May." Gray's commentary on Buckley's paper (Proc. Acad. Nat. Sci. Philadelphia 1862: 334. 1862) indicates that no specimen bearing this name came to Harvard University or to the Academy of Natural Sciences in Philadelphia, although one at the latter herbarium marked "*Agrostis barbatis* Buckl." seems to fit the description, and as Gray remarked: "This is a form of Sporobolus ramulosus." An examination of the material in the Philadelphia Academy[3] reveals that the above-mentioned specimen bears no data as to collector or locality of collection. It is evident from Buckley's paper itself, and particularly from Gray's critique that many of Buckley's species are based on Charles Wright numbers, and the present case is probably no exception. Swallen states[4] that the specimen of *Wright 736* (collected in expedition from western Texas to El Paso, N. Mex., May–Oct. 1849) at the U. S. National Herbarium appears to be identical with the sheet of *Agrostis barbatis* Buckl. in Philadelphia and may well represent the same collection. Bush, who attempted to locate specimens of *M. texana*, states (Amer. Midl. Nat. **7**: 41. 1921): "Hitchcock writes me that Wright's no. 736 is the only specimen [of *M. texana*] in the U. S. National Herbarium from the United States." Buckley's mention of "May" as the time of collection seems further evidence that his description was based upon this Wright specimen. Since the time of collection on that sheet is given as "May–October 1849," Buckley could easily have copied only the "May." It seems significant that the majority of the specimens examined were collected from August to October, and had Buckley himself been the collector he would hardly have made such an error. It seems safe, therefore, to consider that *Wright 736* is the plant upon which Buckley based his description. When that specimen was critically examined it was found to fit unmistakably into *M. minutissima* (Steud.) Swallen, and *M. texana* Buckl. becomes accordingly a synonym of that species. The revised synonymy is as follows:

Muhlenbergia minutissima (Steud.) Swallen, Contr. U. S. Nat. Herb. **29**: 207. 1947.

Agrostis minutissima Steud. Syn. Pl. Glum. **1**: 171. 1854.
Muhlenbergia texana Buckl. Proc. Acad. Nat. Sci. Philadelphia 1862: 91. 1862.
Muhlenbergia Buckleyana Scribn. Contr. U. S. Nat. Herb. **1**: 56. 1890. (Based on *M. texana* Buckl. Name changed because supposed to be a later homonym of *M. texana* Thurb., 1874.)
Podosaemum texanum (Buckl.) Bush, Amer. Midl. Nat. **7**: 41. 1921.
Sporobolus minutissima (Steud.) Hitchc. Proc. Biol. Soc. Washington **41**: 161. 1928.

For the citation of representative specimens see Swallen (Contr. U. S. Nat. Herb. **29**: 207–208. 1947).

This and the following species are closely related and, to those not thoroughly familiar with the group, the distinctions may seem too slight for specific designation. The most useful characters for differentiating them seem to be the longer spreading pedicels and the slightly shorter lemmas with distinctly shorter awns in *Muhlenbergia minutissima*. Although the lemmas rarely have awns 1 mm or more in length, for the most part they are either lacking or not over 0.5 mm

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for this study. Specimens have also been examined in the U. S. National Herbarium (US) through the courtesy of Jason R. Swallen, and in the Chicago Natural History Museum (F) through the kindness of Paul C Standley. Specimens in the Herbarium of Yale University (YU) have also been studied. I am especially indebted to my husband, Dr. John R. Reeder, for his aid in the preparation of the manuscript.

[3] I am indebted to Jason R. Swallen for examining and verifying the material in Philadelphia, as well as for supplying notes on the specimens there.

[4] In personal communication.

long. Moreover, the long-awned spikelets seem to occur at the tips of the panicle branches, while the lower spikelets are awnless or short-awned.

There remained specimens, largely from Mexico, with only a few from Arizona and New Mexico, which did not fit the description of *Muhlenbergia minutissima* and which had heretofore been referred to *M. texana* Buckl. Since no name was found to be available, a new one is here proposed:

Muhlenbergia eludens C. Reeder, sp. nov.

Annua 15–40 cm alta; culmis erectis vel adscendentibus 2–4-nodosis, gracilibus teretibus simplicibus vel e nodis inferioribus ramosis, strigosis saltem infra nodis; vaginis carinatis scaberulis vel plus minusve puberulis quam internodis plerumque brevioribus; ligula membranacea erosa vel lacerata, 1.5–2.5 mm longa; laminis plerumque erectis anguste linearibus involutis saltem in sicco, 1–10 (plerumque 2–5) cm longis, circiter 1 mm latis, supra pubescentibus, subtus scabris vel plus minusve puberulis; paniculis patentibus anguste pyramidalibus saltem 2/3 altitudo herbae aequalibus ad 7 cm latis, axi scaberula vel substrigosa, ramis capillaribus scabris adscendentibus vel late patentibus, inferioribus plerumque 2.5–5 cm longis, ramis secundariis paucis circiter 0.5 cm longis; pedicellis gracilibus adpressis scabris circiter 0.5–2.0 mm longis, infra spiculam dilatis; glumis subaequalibus (gluma prima paullo breviore), 1-nervis, acutis, acuminatis vel attenuatis, 1–2 mm longis pubescentibus saltem apicem versus; lemmate subhyalino (arista 1.5–3.5 mm longa exclusa) circiter 2–2.5 mm longo, 3-nervo, apice bifido, marginibus et nervo centrali saltem basim versus sericeo, callo minute sericeo; palea glabra lemmati subaequali; antheris circiter 0.5–0.6 mm longis; fructibus maturis circiter 1.5 mm longis.

United States: New Mexico: Datil Forest, *Koogler K-1* (*Forest Service 50696*) (US). Arizona: Cochise County: Rucker Canyon, Chiricahua Mountains, *Gould & Haskell 4589* (ARIZ), Reef Mine, Huachuca Mountains, *Darrow, Gould, Phillips & Pultz 1490* (ARIZ).

Mexico: Chihuahua: Sánchez, *Hitchcock 7664½* (US); Miñaca, in bed of rocky run, alt. about 2,100 meters, *Hitchcock 7768* (ARIZ, US, YU, Type) October 13, 1910; near Chihuahua, *Pringle 399* (F, NY, US) (wet ledges of rocky hills), *400* (F, NY, US) (on gravel bars of streams); Sierra Madre, *Pringle 3052* (NY, US), (*sine coll. no.*) (US); Río Negro, *Le Sueur 0196* (US); Noragachi, *Palmer 3d* in 1885 (US). Durango: Sandia Station, alt. about 2,000 meters, *Pringle 13629* (US).

The new species resembles *Muhlenbergia minutissima* in having pubescent glumes and an open panicle, but that species differs in having longer capillary pedicels (2–4 mm long) and smaller spikelets (1–1.7 mm long), in which the glumes are slightly shorter. The lemma is shorter and bears an awn only 0.1–0.5 (rarely to 1.0) mm long.

Muhlenbergia eludens is also closely related to *M. flavida* Vasey, in which the glumes are aristate

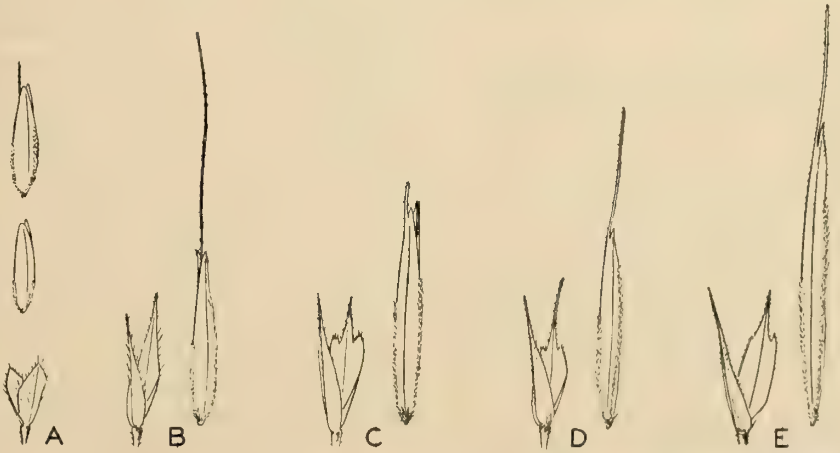

Fig. 1.—Spikelets of *Muhlenbergia minutissima* and its allies: A, *M. minutissima*, awnless floret and glumes (*Fendler 986*) and awned floret (*Wright 736*); B, *M. eludens* (type); C, *M. schmitzii* (*Pringle 8951*); D, *M. flavida* (*Palmer 645*); E, *M. strictior* (*Pringle 1418*). All × 10.

but not uncommonly also with a short tooth on one or both sides of the midnerve. The glumes are, moreover, glabrous or scabrous near the apex, rather than pubescent, and the lemmas tend to be longer (2.5–3 mm). A further difference is seen in the inflorescence which comprises less than half the total height of the plant.

Since *Muhlenbergia eludens* has several close allies, the following key and notes are included as an aid in the identification of members of this complex:

1*a*. Glumes glabrous or scabrous, at least near the apex.
  2*a*. Plants 50–75 cm tall; lemma mucronate or short-awned (the awn not more than 0.5 mm); anthers 1–1.5 mm long. *M. schmitzii*
  2*b*. Plants commonly not over 35 cm tall; lemma with an awn 1.5–2 mm long (rarely longer); anthers 0.5–0.8 mm long.
    3*a*. Lemma 2.5–3 mm long; panicle open (1–4 cm. wide), the branches ascending. *M. flavida*
    3*b*. Lemma mostly 3.5–4 mm long; panicle mostly contracted (1 cm or less wide), the branches appressed. .*M. strictior*
1*b*. Glumes pubescent to short pilose.
    4*a*. Pedicels 2–4 mm long, spreading; lemma 1–1.7 mm long, awnless or with an awn 0.1–1.0 (mostly 0.1–0.5) mm long. *M. minutissima*
    4*b*. Pedicels mostly not over 2 mm long, appressed; lemma 2–2.5 mm long, with an awn about 1.5–3.5 mm long. *M. eludens*

Muhlenbergia schmitzii Hack., Ann. Nat. Hofmus. Wien **17:** 255. 1902. (Type from Mexico, *Schmitz 380*.)

M. Diehlii M. E. Jones, Contr. West. Bot. **14:** 13. 1912. (Type from Mexico, *M. E. Jones 7316*.)

MEXICO: Chihuahua: Sierra Madre Mountains, Guayanopa Canyon, alt. about 1,500 meters, *M. E. Jones 7316* (US). Hidalgo: Canales Station, alt. about 1,800 meters, *Pringle 8951* (F, NY, US). Mexico: Temascaltepec, Comunidad, alt. 2,460 meters, *Hinton 1565* (NY, US). Without precise locality, *Schmitz 380* (F, US).

Muhlenbergia flavida Vasey, Contr. U. S. Nat. Herb. **1:** 282. 1893. (Type from Mexico, *Palmer 645* in 1886.)

MEXICO: Jalisco: Río Blanco, *Palmer 645* in 1886 (US, YU); ravines near Guadalajara, alt. about 1,500 meters, *Pringle 11749* (F, US).

Muhlenbergia strictior Scribn. ex Beal, Grasses N. Amer. **2:** 263. 1896. (Type from Mexico, *Pringle 1418*).

M. flavida Vasey var. *strictior* (Scribn. ex Beal) Scribn. ex Urbina, Cat. Pl. Mex. 394. 1897.
M. madrensis M. E. Jones, Contr. West. Bot. **14:** 12. 1912. (Type from Mexico, *M. E. Jones 7315*.)

MEXICO: Chihuahua: Sierra Madre, *Pringle 1418* (F, NY, US), *1699* (US), *3034* (F, NY, US); Round Valley, alt. about 2,100 meters, *M. E. Jones 7315* (US); Sánchez, *Hitchcock 7673* (US); Miñaca, alt. about 2,100 meters, *Hitchcock 7765* (ARIZ, NY, US, YU). Durango: Sierra Madre Occidental, El Salto, Pineland Canyon, alt. 2,500–2,530 meters, *Pennell 18513* (US); Sandia Station, alt. 2,000 meters, *Pringle 13630* (US). Federal District: Valley of Mexico, *Pringle in 1903* (US).

Presumably the grasses that Pringle collected in Mexico in 1887–88 were sent to Scribner for determination. Both the specimen Beal cited (*Pringle 1418*, Sept. 1887) and the one cited by Urbina (*Pringle 3034*, Oct. 1888) bore the printed herbarium name "*Muhlenbergia flavida* Vasey var. *strictior* Scribner," which was, however, never published by Scribner. These two specimens have been examined by the writer and are certainly conspecific.

Beal lists under *Muhlenbergia strictior:* "*M. flavida* var. *strictior* Scribn. ined." This cannot be considered the basonym, nor does it constitute publication of the variety since according to the International Rule (art. 40): "A name of a taxonomic group is not validly published when it is merely cited as a synonym." Therefore, *M. strictior* is actually a new species described by Beal but credited to Scribner and should be cited "Scribn. ex Beal."

Urbina, in using the name *Muhlenbergia flavida* var. *strictior*, apparently did not realize, as did Beal, that it was ined. Since, however, the name *M. strictior* Scribn. ex Beal, published a year earlier, was based on the same material (although not on the same specimen) for all practical purposes it seems proper to consider that Urbina's variety was based upon that species. The correct citation for the variety is, then: *M. flavida* Vasey var. *strictior* (Scribn. ex Beal) Scribn. ex Urbina.

Hitchcock states (North American Flora **17**(6): 438. 1935) in regard to *Muhlenbergia flavida* var. *strictior*: "Differing [from the species] only in the contracted panicle." Examination of the types and other available material reveals, however, that there are other differences. Although the glumes are 1.5–2 mm long in both cases, the relationship of glumes to floret is not the same due to a difference in the floret length, which is about 1 mm longer in *M. strictior*. Whereas in *M. flavida* the glumes are about two-thirds as long as the floret, in *M. strictior* they are scarcely half as long. In view of these differences, which appear to be as significant as those separating other species in the genus, it seems advisable to reinstate the name which was used by Beal.

Although *Pringle 3034* is unusual in having the panicle branches somewhat stiffly spreading, they are not slender and lax as are those of *M. flavida*. In all other characters it agrees well with the type of *M. strictior*.

ENTOMOLOGY.—*Notes on some West Indian Chrysomelidae.*[1] Doris H. Blake, Arlington, Va.

This paper deals with six new species of Chrysomelidae from the West Indies that have come to the writer's attention as well as notes on certain changes in the generic status of two other described species.

Alethaxius bruneri, n. sp.

Fig. 6

About 3 mm in length, oblong oval, dark lustrous green with reddish antennae, mouthparts, and tarsi, the tibiae a little darker and the femora tending to be piceous; one male, possibly immature, paler in color with reddish elytra having a green luster, the legs and body beneath reddish; all femora toothed, female with nodules on sides of elytra; thorax densely and finely punctate, not quite twice as wide as long, with two lateral teeth.

Head shining green with reddish-brown mouthparts, upper part with scattered punctures becoming denser lower down between the eyes; in one specimen a little pit on the vertex, sometimes a median impressed line; eyes entire. Antennae reddish brown or darker, about half the length of the beetle, first two joints swollen, third and fourth not so long as fifth, last five joints longer and thicker. Prothorax not quite twice as wide as long, with two lateral teeth, a broad tooth anteriorly and a smaller one at basal angle; except around the margin the surface very densely punctate. Elytra of female with tubercles along sides from the prominent humeri to the middle; in male these lacking; a slight lateral depression below the intrahumeral sulcus; basal third densely punctate, the punctures then becoming sparser and irregularly 8-striate. Body beneath dark brown or piceous, finely alutaceous and with fine white pubescence. All femora toothed; tending to be dark brown or piceous in color, the tibiae and tarsi paler. Length 2.7–3.2 mm; width 1.6–1.8 mm.

Type male and 3 paratypes, U.S.N.M. no. 59313.

Type locality.—Palma Mocha to Pico Joaquin, Sierra Maestra, Cuba, elevation 3,500–5,300 feet, collected on May 18, 1948, by J. Acuña and J. Ferrás.

Other localities.—Sierra Maestra, 3,600–3,900 feet, collected on May 15–16, 1948, by J. Ferrás.

Remarks.—This is smaller and greener and less densely punctate than the coppery colored *A. turquensis* Blake and has a wider prothorax and darker femora.

Blepharida irrorata Chevrolat

Blepharida irrorata Chevrolat, Rev. Mag. Zool. (2) **16**:182. 1864.

Haltica adspersula Suffrian, Arch. für Naturg. **38** (1): 185. 1868.

Disonycha adspersula (Suffrian), Junk Catalogue.

S. C. Bruner has recently sent me a specimen identified by Manuel Barro as *Disonycha adspersula* (Suffrian). On comparing it with Suffrian's description, I find that it agrees with that species. However, it is simply the dark color form of *Blepharida irrorata* Chevrolat, and Chevrolat's name antedates Suffrian's by four years. Suffrian assigned this color form simply to *group b* under *Haltica*, with no indication that he believed it to be a *Disonycha*.

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[1] Received July 27, 1949.

Aphthona schwarzi, n. sp.

Fig. 5

About 1.5 mm in length, oblong oval, yellowish or reddish brown with a faint brownish band across the middle of the elytra and a slight darkening along the base, these markings not visible in all specimens; antennae pale with joints 8–10 dark.

Head shining and smooth with the usual line from antennal socket to upper eye and a small fovea near eye, frontal tubercles faintly indicated, interantennal area moderately broad but not produced at all. Antennae pale with joints 8–10 black, joints 2, 3, and 4 subequal and shorter than fifth. Prothorax wider than long with truncate anterior angles and arcuate sides; shining and distinctly punctate. Elytra broad, shining, distinctly striate punctate throughout, with a deeper reddish brown band across the middle and a faint shading along the base, these markings not apparent in all specimens. Body beneath shining and entirely pale, first tarsal joint of hind legs moderately long. Length 1.3–1.4 mm; width 0.8 mm.

Type male and 4 paratypes U.S.N.M. no. 59316.

Type locality.—Cayamas, Santa Clara Province, Cuba, collected on June 2 by E. A. Schwarz.

Remarks.—This tiny species also belongs to the group of pale brown species related to *insolita* Melsheimer, which Crotch assigned to the genus *Cerataltica*. It differs from *A. fraterna* and *A. elachia* Blake by having joints 8–10 black, the former having joints 6–9 black and *elachia* having joints 8–9 black. It is also unlike them in having a more or less distinct band across the elytra.

Aphthona nana, n. sp.

Fig. 3

About 1.3 mm in length, oblong oval, shining yellowish or reddish brown with slightly darker antennae; prothorax very faintly and finely punctate, elytral striae rather indistinct.

Head shining, very finely and indistinctly punctate, frontal tubercles outlined by a fine line across with two or more punctures grouped about the line at the upper edge of eye; interantennal area rather wide and somewhat produced into a carina. Antennae a little darker than rest of body, second, third, and fourth joints subequal. Prothorax a little wider than long, the sides only feebly arcuate with an oblique anterior angle and a tiny basal tooth; lustrous, very faintly and finely punctate. Elytra a little wider than prothorax with fine striate punctation becoming very faint at sides and apex. Body beneath and legs entirely pale and shining. First joint of hind tarsi long. Length 1.3 mm; width 0.6 mm.

Type male and 1 paratype, U.S.N.M. no. 59315.

Type locality.—Caimito, Habana Province, Cuba, collected on August 23, 1917, by Harold Morrison.

Other locality.—Baraguá, Cuba, collected on October 14, 1927, by L. C. Scaramuzza.

Remarks.—Although smaller and more slender than any of the other species of the group allied to *insolita* Melsheimer, this species plainly belongs with them.

Aphthona inornata, n. sp.

Fig. 1

About 2 mm in length, oblong oval, shining yellowish or reddish brown with the distal joints of the antennae a little deeper brown; prothorax finely and densely punctate, the striate punctures of the elytra faint on lower sides and apex.

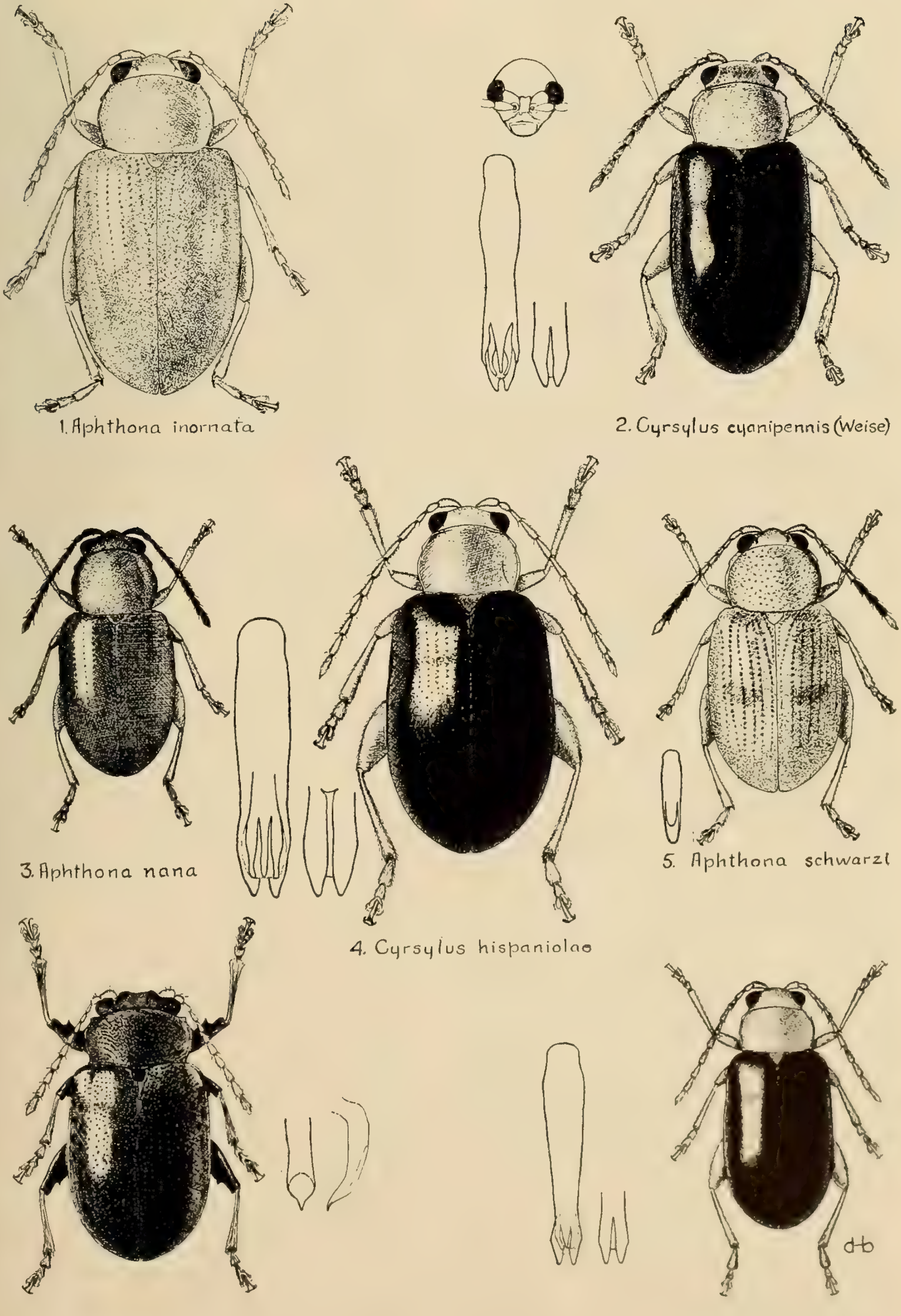
Head polished, impunctate except for one or two punctures near the top of the eye close to the oblique line running up from the antennal socket to upper margin of eye; frontal tubercles indistinct, interantennal area broad and somewhat produced. Antennae with pale basal four joints and darker distal joints, third joint shorter than fourth. Prothorax wider than long, finely and densely punctate; shining, smoothly convex, with arcuate sides. Elytra broader than prothorax, smoothly convex, shining, the striate punctures faint on the sides below the middle and towards the apex. Body beneath entirely pale, shining, very finely pubescent; legs entirely pale, the first joint of hind tarsi rather long. Length 1.8 mm; width 1 mm.

Type female, U.S.N.M. no. 59314.

Type locality.—Río Piedras, Puerto Rico, collected on July 31, 1914, by T. H. Jones.

Other locality.—Anasco District, Puerto Rico, collected on July 3, 1917, by Harold Morrison.

Remarks.—This also belongs to the *Ceratalitica* group and is closely related to *insolita* Melsheimer from North America and *A. fraterna* and *elachia* Blake from Haiti, but, unlike them, it does not have the antennae in part black.



FIGS. 1–7.—West Indian Chrysomelidae.

Cyrsylus cyanipennis (Weise)

Fig. 2

Podagrica cyanipennis Weise, Arch. für Naturg. **51** (1): 165. 1885.

From 2.8–4 mm in length, elongate oblong, lustrous, reddish brown with slightly darker antennae and deep blue elytra; thorax smoothly convex and without depressions, with obliquely truncate anterior angles and nearly straight basal margin, distinctly margined; elytra striate punctate in basal third becoming confusedly punctate before the middle. Anterior coxal cavities closed, hind femora swollen, a tiny spur at the end of the hind tibiae, the first hind tarsal joint in male dilated.

Head smoothly rounded over occiput, finely punctate; eyes entire, a moderately broad interspace between antennal sockets, distinctly carinate and not extending much down lower front, above limited by a fine depressed line running across front to eye and disappearing along the upper margin of eye; no evidence of frontal tubercles or fovea near the eye. Antennae moderately stout, not reaching the middle of the elytra, first and second joints swollen, third not much longer than second, fourth a little longer. Prothorax not quite twice as wide as long with sides only slightly arcuate, nearly straight, a small tooth at basal angle; basal as well as anterior margin nearly straight across giving the thorax a rectangular appearance; surface lustrous, smoothly convex without depressions, finely punctate. Elytra wider than thorax, moderately convex, especially in apical half, with a transverse depression below the basal callosities; surface striately punctate over the basal callosities and in the depression below with indistinct punctures between the rows, the punctation becoming confused and finer before the middle. Epipleura broad, disappearing at apical angle. Body beneath entirely pale; lustrous under the light pubescence; anterior coxal cavities narrowly closed; hind femora thickened, hind tibiae round not flattened or channelled, with a tiny spur at tip; first joint of hind tarsi swollen in male, claws appendiculate, almost toothed.

Type locality.—St. Thomas, Virgin Islands.

Remarks.—The only species of this group previously described from the West Indies is *Podagrica cyanipennis,* which Weise described from St. Thomas. The name is possibly taken from DeJean's Catalogue, where it is used without description for a species from Santo Domingo. The coloring, reddish brown with blue elytra, is similar to that of many species of *Podagrica,* as are also the closed coxal cavities and to a limited degree the elytral punctation, which in some species of *Podagrica* is striate in the basal half and confused below. *Podagrica* is a European and Asiatic genus of which there are no other representatives in the Western Hemisphere. In this West Indian group of three species the differences far outweigh the resemblances to *Podagrica.* The beetles are narrower and more convex, the antennae are not so much thickened, the prothorax has truncate and not toothed anterior angles and entirely lacks the small depressions at the base, the elytral punctation is much sparser, and the tibiae are not divided at the end into two lobes. As Weise himself wrote, the beetles are deceivingly like *Aphthona compressa* Suffrian, a species recently assigned by the writer to a new genus *Homoschema.* The thorax is similar and the hind tibiae are alike, but the coxal cavities are narrowly closed and the elytra are more elongate with striate punctation in the basal part. The aedeagus, similar in all three West Indian species here described, is unlike any in *Homoschema* and most peculiar in that the tip is divided for some distance. The genus *Aphthona* has been used to include a great many American species that are not like the European. In this case there are too many dissimilarities to allow its inclusion. Jacoby's genus *Palaeothona* includes some species from Central America that superficially bear more of a resemblance. In fact, one species from Costa Rica even has a somewhat similar peculiarity of the aedeagus, this having a distinct cleft on the lower surface. But in *Palaeothona,* also, the coxal cavities are open, not closed. The genus *Aphthonella,* genotype *A. blamoensis* Jacoby from India, has closed cavities and a long first segment of the posterior tarsi, the elytra are regularly punctate striate, the hind tibiae (unlike this species) are channeled, and the claws appendiculate, but the illustration in *The fauna of British India* shows a quite differently shaped head and prothorax. Jacoby's genus *Cyrsylus,* composed of five species from Central America, appears to be the best fitted to include this species and the two other ones like it in the West Indies. *C. recticollis* Jacoby, a fairly common species throughout Central America, is entirely brown, but *C. crassi-*

cornis has metallic green elytra, and Jacoby writes that it strongly resembles a species of *Palaeothona* except for the closed coxal cavities. The only species of *Cyrsylus* examined by me, *C. recticollis*, is similar in size and shape to *cyanipennis*, the only marked difference being in the elytral punctation which is regularly striate punctate throughout. The head has a similar sculpture, the thorax is rectangular with oblique anterior angles, and a straight margined base. The first joint of the hind tarsus is long and appears to be likewise dilated in the male. The aedeagus, while not having the peculiar divided apex, is long, slender and not much curved.

This species has also been collected at Fajario, Puerto Rico, by August Busck in February 1899 and at Christiansted, St. Croix, by H. A. Beatty.

Cyrsylus hispaniolae, n. sp.

Fig. 4

From 4–4.5 mm in length, oval, lustrous, yellow-brown with deep blue elytra, elytra distinctly punctate.

Head shining, smooth, impunctate. Antennae with second and third joints subequal, fourth and remaining nearly twice as long as third, pale yellow-brown. Prothorax very finely and indistinctly punctate, about one-fourth as long as elytra. Elytra broad and convex with distinct rows of punctures in basal part, and between these rows of coarser punctures a row of finer, indistinct punctures; below the transverse depression the punctation becoming confused; occasionally the rows somewhat impressed. First joint of hind tarsus long and in the male dilated. Length 3.9–4.5; width 2–2.3 mm.

Type male and 12 paratypes U.S.N.M. no. 59317, 2 paratypes in Museum of Comparative Zoology, Cambridge, Mass.

Type locality.—Froide River Valley, Haiti, collected on January 28, 1925, by W. A. Hoffman.

Remarks.—Except for the points noted above, this species is much like *C. cyanipennis* (Weise). It is the largest and most robust of the three species with the most distinct punctation.

Cyrsylus montserrati, n. sp.

Fig. 7

About 3 mm in length, elongate, lustrous, reddish brown, with deep blue elytra.

Head shining, smoothly rounded over occiput with a few fine punctures on top, paler in lower front. Antennae with third joint about the same length as second and shorter than fourth. Thorax finely punctate, the sides nearly straight, about one-fourth as long as elytra. Elytra with fine striate punctures becoming confused behind the transverse impression. Undersurface lustrous. First joint of hind tarsi not quite as long as the rest together, dilated in the male. Length 2.9 mm; width 1.4 mm.

Type male, U.S.N.M. no. 59318.

Type locality.—Montserrat, West Indies, collected on March 18 by H. G. Hubbard.

Remarks.—This species, very similar in most points to the two preceding ones, is the smallest and the most finely punctate and also is more slender.

ZOOLOGY.—*Echinoderms from the mid-Atlantic dredged by the* Atlantis *in the summer of 1948.*[1] AUSTIN H. CLARK, U. S. National Museum.

Through Dr. Louis W. Hutchins the Woods Hole Oceanographic Institution has submitted to me for study an unusually interesting collection of sea-stars, brittle-stars, sea-urchins, and sea-lilies from the mid-Atlantic, largely from the general vicinity of the Azores. This collection was made by the *Atlantis* of the Woods Hole Oceanographic Institution on cruise no. 152, sponsored jointly by the National Geographic Society, Columbia University, and the Woods Hole Oceanographic Institution. It is especially interesting in including a number of species that have not been found since the days of the *Challenger*, *Travailleur*, *Talisman*, *Hirondelle*, and *Princesse-Alice*. For the pleasure of studying this collection I am deeply indebted to the Woods Hole Oceanographic Institution and to Dr. Hutchins.

ASTEROIDEA

ASTROPECTINIDAE

Leptychaster arcticus (M. Sars)

Astropecten arcticus M. Sars, Reise i Lofoten og Finmarken, Nyt Mag. for Naturvid. **6:** 161. 1851.

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[1] Contribution from the Woods Hole Oceanographic Institution No. 471. Published by permission of the Secretary of the Smithsonian Institution. Received April 25, 1949.

Locality.—*Atlantis* cruise 152, station 6; east of southern Newfoundland and south of Cape Farewell, Greenland (lat. 47° 08′ N., long. 44° 53′ W.); 85 fathoms; July 31, 1948. Thirteen specimens.

Note.—In all the specimens R = about 30 mm.

Plutonaster notatus Sladen

Plutonaster notatus Sladen, *Challenger* Reports, Zoology, **30** (pt. 51): 97, pl. 14, figs. 6, 7, pl. 15, figs. 5, 6. 1889.

Locality.—*Atlantis* cruise 152, station 28; southwest of the Azores (lat. 34° 50′ N., long. 39° 20′ W.); 1,770 fathoms; August 30, 1948. Three specimens.

Notes.—One of the specimens measures R = 25 mm., r = 8 mm.; in the other two R = 22 mm., r = 8 mm. In one specimen many and in the others a few of the papillae on the abactinal surface have 2 to 4 (usually 3) of the central spines enlarged and swollen, forming a pedicellaria. Two of the specimens have a few similar pedicellariae on the actinal surface.

Dytaster biserialis Sladen

Dytaster biserialis Sladen, *Challenger* Reports, Zoology, **30** (pt. 51): 77, pl. 10, figs. 3, 4, pl. 13, figs. 3, 4. 1889.

Locality.—*Atlantis* cruise 152, station 8; west of Newfoundland and south of Greenland (lat. 47° 10′ N., long. 36° 00′ W.); 2,300 fathoms; August 2, 1948. One specimen.

Notes.—In this specimen R = 43 mm., r = 9 mm.; there are 28 marginals.

Dytaster mollis (E. Perrier)

Crenaster mollis E. Perrier, Expéditions scientifiques du *Travailleur* et du *Talisman* pendant les années 1880, 1881, 1882, 1883, Échinodermes: 310, pl. 18, figs. 3, a, b. 1894.

Locality.—*Atlantis* cruise 152, station 20; west of San Miguel, Azores (lat. 37° 50′ 30″ N., long. 26° 00′ W.); 1,400 fathoms; August 18, 1948. One specimen.

Notes.—There seems to be no doubt that this specimen represents Perrier's *Crenaster mollis*, which was described from a single individual dredged southwest of Terceira, Azores (lat. 38° 38′ N., long. 27° 26′ W.), in 2,995 meters. It does not quite agree in some respects with Perrier's description, which differs slightly from his figures, so that it appears desirable to describe it in detail.

Description.—R = 40 mm., r = 9 mm. The form is stellate with the angles of the star produced into long narrow arms and the interbrachial arcs broadly and regularly rounded.

The plates of the abactinal surface are small, 4 or 5 to a millimeter in the central portion of the disk and along the middle of the rays, gradually becoming larger toward the borders of the interradial areas and rather abruptly larger in the two rows adjacent to the superomarginals, both on the disk and on the arms. The plates are very delicate, thin and glassy, subcircular or polygonal, and where there are interstices between them these are bridged by thin filmy scale-like plates, the whole forming a continuous mosaic. The surface of each plate, except for a narrow glassy rim, is abruptly raised into a stout opaque cylindrical tubercle with a broadly rounded summit, these tubercles being mostly higher than thick; the large tubercles along the interradial margins of the disk are more or less capitate. Each tubercle bears on its summit a group of commonly 6–9 spines arranged in a circle, with or without a central spine. These spines are usually somewhat longer than the tubercle is high, and are slightly flaring and thorny in the distal half. The madreporite is large, situated near the interradial border and almost in contact with the superomarginals. It is surrounded by a ring of about 15 somewhat enlarged spine-bearing tubercles, and carries 4 much enlarged spine-bearing tubercles on its surface.

As viewed from the side the marginals of the two series are equal in size and similar, and the superomarginals lie directly over the inferomarginals so that the line separating them, and the vertical lines separating the pairs, are straight and at right angles to each other. The marginals decrease slowly and regularly in size from the interbrachial arcs outward to the tips of the rays. In the interbrachial arcs the marginals are square, but they soon become about half again as long as broad, in the outer third of the rays slowly decreasing in length and becoming square at some distance from the tips. The inferomarginals encroach more on the actinal than the superomarginals do on the abactinal surface. There are about 30 marginals from the middle of the interbrachial arcs to the tips of the rays.

Viewed on the abactinal surface the two superomarginals in the middle of the interbrachial arcs are slightly higher (radially) than broad. The one on each side of this pair is about as long as broad, and those following soon become about half again as long as broad, in the distal third of the ray slowly decreasing in length and becoming about as long as broad near the tip, with the last few slightly broader than long. The terminal plate is rather large, broadly truncate distally with converging sides and the inner end excavated in approximately a right angle. The superomarginals bear numerous scattered thorny spinules which are separated by about their own length. The two in the middle of each interbrachial arc bear a short slender conical spine, and the one on each side of these bears two smaller spines. None of the others bear spines.

The inferomarginals are covered with scattered spinules similar to those on the superomarginals. The two in the middle of each interbrachial arc bear two median conical spines. The next 15 or 16 on each side each bear a single slender short spine decreasing in size distally, at first central and surrounded by enlarged spinules, soon losing the accompanying enlarged spinules and gradually moving to the distal end of the plates.

On the actinal surface the interactinal areas are occupied by a number of plates which are much larger than the plates of the abactinal surface and are only slightly convex. A somewhat irregular median row runs from the suture between the mouth plates to the suture between the two central inferomarginals; this includes 3 or 4 plates; except for a single plate adjoining the mouth plates, it is absent in one interactinal area. Perrier does not mention this unpaired column in his description, but it appears to be indicated in his figure of the actinal surface (1a). On each side of this there is a column of 3 plates, with a small one next the inferomarginal. Perrier says that these columns have 5 or 6 plates, but his figure seems to show 3 or 4. These columns are followed by a column of 3 plates and a very small one, then two plates and a very small one, then about 4 single plates between the adambulacrals and inferomarginals. The two median inferomarginals each have 4 columns of plates abutting against their inner ends, and those adjacent have 2 or 3. There are 3 columns of plates arising from the mouth plates, and 4 from the first 3 adambulacrals; usually 2 plates adjoin the fourth and fifth adambulacrals, followed by long very narrow plates between the following adambulacrals and inferomarginals. These plates bear usually 12–15 well-spaced spinelets scattered uniformly over the surface which resemble those of the inferomarginals and are much larger than those of the abactinal plates.

The number of adambulacrals is greater than that of the inferomarginals so that the two series do not exactly correspond until about the tenth inferomarginal, which corresponds to the thirteenth adambulacral; from this point on the two series correspond. The inner border of the adambulacrals is regularly curved and bears a comb of 9 slender spines of which the two outermost are the shortest. On the outer edge of the plate there is a straight row of 6 or 7 subequal shorter and rougher spines. In the distal third of the arms the adambulacrals develop a single long spine on the actinal surface.

The mouth plates were well described by Perrier. There are no pedicellariae.

GONIASTERIDAE

HIPPASTERINAE

Hippasteria phrygiana (Parelius)

Asterias phrygiana Parelius, Kgl. norwegischen Ges. Wiss. (zu Drontheim) Schriften, aus dem dänischen Übersetzt, Teil 4: 349, 350, pl. 15, figs. 1, 2. 1768.

Locality.—*Atlantis* cruise 152, station 6; east of southern Newfoundland and south of Cape Farewell, Greenland (lat. 47° 08′ N., long. 44° 52′ W.); 85 fathoms; July 31, 1948. One specimen.

Notes.—This specimen is large, with R = 175 mm., r = 75 mm. The disk is subcircular and tumid, abruptly separated from the rays, which are 30 mm. wide at the base and are separated from each other by a distance of 60 mm. The rays are high and evenly rounded abactinally.

Especially remarkable is the great size of the pedicellariae. Those on the abactinal surface are 3 mm. long. On the actinal intermediate plates the numerous pedicellariae are about 5 mm. long. Each of the plates of the series between the inferomarginals and the adambulacrals bears an enormous pedicellaria; on the disk these are set at an angle of about 60° to the ambulacral groove, but on the rays they are more or less at right angles to it. On the disk these pedicellariae are from 6 to 10 (mostly about 8) mm. long; on the rays they slowly decrease to 3 mm. at the end of the series, about 20 mm. from the tips.

ASTEROPIDAE

Poraniomorpha borealis (Verrill)

Asterina borealis Verrill, Amer. Journ. Sci. **16**: 213. 1878.

Locality.—*Atlantis* cruise 152, station 6; east of southern Newfoundland and south of Cape Farewell, Greenland (lat. 47° 08′ N., long. 44° 52′ W.); 85 fathoms; July 31, 1948. One specimen.

Note.—The single specimen is large, with R = 57 mm., r = 37 mm.

ECHINASTERIDAE

Henricia sanguinolenta (O. F. Müller)

Asterias sanguinolenta O. F. Müller, Zoologiae Danicae Prodromus: 234. Havniae, 1776.

Locality.—*Atlantis* cruise 152, station 6; east of southern Newfoundland and south of Cape Farewell, Greenland (lat. 47° 08′ N., long. 44° 52′ W.); 85 fathoms; July 31, 1948. Thirty-one specimens.

Note.—In these specimens R = 11 to 37 mm.

Henricia lisa, n. sp.

Description.—The single specimen is in poor condition. It was completely encased in mud and ooze the removal of which resulted in the loss of most of the spines.

R = 26 mm. r = 7 mm. The form is stellate with the points of the star much produced. The arms taper rapidly to about 15 mm. from the center of the disk, thence slowly to the rounded tip. The interradial arcs form an obtuse angle with straight sides. The disk and the stout basal portion of the arms were apparently inflated in life.

The abactinal skeleton is very dense, composed of a great number of small and mostly slightly elongated plates among which are interspersed rounded or polygonal plates, especially about the papular pores, with occasional small independent subcircular plates in the interstices. Numerous single papulae occur between the plates, except in a broad line from the middle of the interbrachial arcs about half way to the center of the disk where the plates are larger and shorter than elsewhere with the inner ends elevated and imbricating, and are closely appressed against each other with no interspaces. Presumably in life this solid line of plates was depressed, forming a sulcus. All the plates are strongly and smoothly convex.

The abactinal skeleton in general resembles that of certain forms of *Henricia leviuscula*, but the plates are much smaller, lower, and more densely packed, all the papulae being single.

Each plate appears to bear a regular or irregular row of usually 3 or 4, sometimes 2 or even only 1, short and fine spines; on the plates in the interradial lines there are usually 2, sometimes 1 or 3, spines on the highest (inner) portion.

The madreporite, situated about half way between the center and margin of the disk, is large and prominent, about 2 mm. in diameter, and, in the dry specimen, is elevated above the surface of the disk. It is coral-like, but bears a number of spines scattered over its surface.

The plates of the abactinal surface are continued around the margin of the disk onto the actinal surface where they become somewhat higher with a more or less developed median crest. Except in a broad central band, a continuation of the interradial band of the abactinal surface, which reaches nearly to the mouth plates, they become aligned with their long axes at right angles to the margin of the disk and arranged in somewhat irregular transverse and longitudinal rows. The inferomarginals, scarcely distinguishable from the other plates, are separated from the adambulacrals by a single row of actinal intermediate plates which extends at the twentieth or twenty-fourth adambulacral. Near the mouth plates the plates of the actinal intermediate series are as large as, or larger than, the inferomarginals and bear a comb of 2–4 spinelets, but they soon decrease in width and become subcircular.

The two series of inferomarginals in each actinal interradial area almost meet just beyond the mouth plates, being separated by the narrow inner end of the irregular band of plates in the middle of the areas. The superomarginals are indistinguishable in these areas. There is a more or less deficient row of papulae between the inferomarginals and the actinal intermediate plates. The plates of the interradial areas bear a row of 4–6 spinelets resembling those on the abactinal surface but longer.

The adambulacral plates are short and broad, the largest plates on the rays. They bear a regular or somewhat irregular row of 6–8 spines of which the innermost (sometimes the two innermost) is abruptly larger and stouter than the others, which are short and decrease in length outwardly. At the inner angle of the plate, deep within the furrow, there is a stout conical spine, shorter than the large spine at the end of the series on the actinal surface.

The mouth plates are about three times as long as broad. The two of each pair curve about a broad central cavity, being separated at their outer ends but broadly in contact at their tips. Each mouth plate bears a series of about 7 stout spines along the outer edge, and a similar series along the inner edge. Each pair of mouth plates has at the tip a single unpaired spine.

Type.—U.S.N.M. no. E. 7774, from *Atlantis* cruise 152, station 8; southeast of Newfoundland and west of the Azores (lat. 47° 10′ N., long. 36° 00′ W.); 2,300 fathoms; August 2, 1948.

Notes.—It is with much diffidence that I propose a new specific name in this perplexing genus, but the present specimen is so different from any previously recorded that it seems reasonable to assume that it represents a new specific type. Of all the named species and forms it comes nearest to *Henricia sanguinolenta eschrichtii* forma *tumida* Verrill as represented by some specimens at hand from the Bering Sea area, with unusually dense abactinal skeletons. But the rays are tumid only in the proximal half, the skeleton is more compact and composed of smaller plates which are evenly rounded dorsally without ridges or bosses, the marginal plates are not clearly defined, the spinelets on all the plates are longer and more slender, and the papulae are invariably single.

PTERASTERIDAE

Pteraster militaris (O. F. Müller)

Asterias militaris O. F. Müller, Zoologiae Danicae Prodromus: 234. Havniae, 1776.

Locality.—*Atlantis* cruise 152, station 6, east of southern Newfoundland and south of Cape Farewell, Greenland (lat. 47° 08′ N., long. 44° 52′ W.); 85 fathoms; July 31, 1948. One specimen.

Notes.—The single specimen is four-rayed; R = 16 mm., r = 7 mm.

BRISINGIDAE

Freyella abyssicola E. Perrier

Freyella spinosa var. *abyssicola* E. Perrier, Expéditions scientifiques du *Travailleur* et du *Talisman* pendant les années 1880, 1881, 1882, 1883, Échinodermes: 88. 1894. One specimen.

Locality.—*Atlantis* cruise 152, station 8; east of Newfoundland and south of Greenland (lat. 47° 10′ N., long. 36° 00′ W.); 2,300 fathoms; August 2, 1948.

Notes.—The single specimen has the disk 11 mm. in diameter and the 11 rays 85 mm. long. Four of the rays, opposite the madreporite, are slightly smaller than the others.

This specimen agrees closely with Perrier's type from northeast of the Azores (lat. 42° 19′ N., long. 23° 36′ W.), in 4,060 meters, which also had 11 rays.

ASTERIIDAE

PEDICELLASTERINAE

Hydrasterias ophidion Sladen

Asterias (*Hydrasterias*) *ophidion* Sladen, *Challenger* Reports, Zoology, **30** (pt. 51): 581, pl. 99, figs. 3, 4, pl. 103, figs. 3, 4. 1889.

Locality.—*Atlantis* cruise 152, station 20; north of the Azores (lat. 37° 50′ 30″ N., long. 26° 00′ W.); 1,400 fathoms; August 18, 1948. 10+ specimens.

Notes.—All the specimens have 6 rays; R = about 35 mm.

ASTERIINAE

Asterias vulgaris Verrill

Asterias (*Asteracanthion*) *vulgaris* (Stimpson, MS.) Verrill, Proc. Boston Soc. Nat. Hist. **10:** 347. 1866.

Locality.—*Atlantis* cruise 152, station 6; east of southern Newfoundland and south of Cape Farewell, Greenland (lat. 47° 08′ N., long. 44° 52′ W.); 85 fathoms; July 31, 1948. One specimen.

Note.—The single specimen is small, with R = 11 mm.

OPHIUROIDEA

OPHIACANTHIDAE

Ophiacantha abyssicola G. O. Sars

Ophiacantha abyssicola G. O. Sars, Nye Echinod. fra den norske Kyst., Vid. Selsk. Forh. Christiania: 8. 1871.

Locality.—*Atlantis* cruise 152, station 26; southwest of the Azores (lat. 34° 12′ 30″ N., long. 30° 12′ 30″ W.); 570 fathoms; August 26, 1948. One small specimen.

OPHIACTIDAE

Ophiactis abyssicola (M. Sars)

Amphiura abyssicola M. Sars, Norges Echin.: p. 18, pl. 2, figs. 7–12. 1861.

Locality.—*Atlantis* cruise 152, station 11; north of the Azores (lat. 42° 53′ 30″ N., long. 29 05′ W.); 720 fathoms; August 10, 1948. Two specimens.

Ophiopholis aculeata (Linné)

Asterias aculeata Linné, Syst. Nat., ed. 12, **1** (pt. 2): 1101, No. 12. 1767.

Locality.—*Atlantis* cruise 152, station 6; east of southern Newfoundland and south of Cape Farewell, Greenland (lat. 47° 08′ N., long. 44° 52′ W.); 85 fathoms; July 31, 1948. Thirty-eight specimens.

Note.—All the specimens are small, the largest having the disk 9 mm. in diameter.

Ophiolepididae

Amphiophiura convexa (Lyman)

Ophioglypha convexa Lyman, Bull. Mus. Comp. Zool. **5**: 84, pl. 3, figs. 83, 84. 1878.

Localities.—*Atlantis* cruise 152, station 8; east of Newfoundland and south of Greenland (lat. 47° 10′ N., long. 36° 00′ W.); 2,300 fathoms; August 2, 1948. Eleven specimens.

Station 30; between North Carolina and the Azores (lat. 34° 53′ N., long. 46° 24′ W.); 2,530 fathoms; September 3, 1948. One specimen.

Notes.—The largest specimen from station 8 has the disk 15 mm. in diameter and the arms 30 mm. long. The single specimen from station 30 has the disk 12 mm. in diameter and the arms 24 mm. long.

Ophiura sarsii Lütken

Ophiura sarsii Lütken, Vidensk. Meddel., 1854: 101. 1855.

Locality.—*Atlantis* cruise 152, station 6; east of southern Newfoundland and south of Cape Farewell, Greenland (lat. 47° 08′ N., long. 44° 52′ W.); 85 fathoms; July 31, 1948. Six specimens.

Note.—The largest specimen has the disk 20 mm. in diameter.

Ophiura irrorata (Lyman)

Ophioglypha irrorata Lyman, Bull. Mus. Comp. Zool. **5**: 73, pl. 4, figs. 106–108. 1878.

Locality.—*Atlantis* cruise 152, station 8; east of Newfoundland and south of Greenland (lat. 47° 10′ N., long. 36° 00′ W.); 2,300 fathoms; August 2, 1948. Three specimens.

Note.—The largest specimen has the disk 23 mm. in diameter and the arms 125 mm. long.

Ophiura ljungmani (Lyman)

Ophioglypha ljungmani Lyman, Bull. Mus. Comp. Zool. **5**: 71, pl. 3, fig. 77. 1878.

Locality.—*Atlantis* cruise 152, station 11; north of the Azores (lat. 42° 53′ 30″ N., long. 29° 05′ W.); 720 fathoms; August 10, 1948. Five specimens.

Note.—The largest specimen has the disk 6 mm. in diameter and the arms 16 mm. long.

Ophiocten sericeum (Forbes)

Ophiura sericea Forbes, Journ. Sutherland's Voy. **2**: App.: 215. 1852.

Locality.—*Atlantis* cruise 152, station 6; east of southern Newfoundland and south of Cape Farewell, Greenland (lat. 47° 08′ N., long. 44° 52′ W.); 85 fathoms; July 31, 1948. 203 specimens.

Note.—All the specimens are small, the largest with the disk about 5 mm. in diameter.

ECHINOIDEA

Strongylocentrotidae

Strongylocentrotus dröbachiensis (O. F. Müller)

Echinus dröbachiensis O. F. Müller, Zoologiae Danicae Prodromus: 235. Havniae, 1776.

Locality.—*Atlantis* cruise 152, station BT 65; 200 meters; July 21, 1948. One specimen.

Note.—The specimen is 36 mm. in diameter.

Scutellidae

Echinarachnius parma (Lamarck)

Scutella parma Lamarck, Hist. nat. des animaux sans vertèbres **3**: 11. 1816.

Locality.—*Atlantis* cruise 152, station 1; south of Nantucket, Massachusetts (lat. 40° 50′ N., long. 70° 10′ W.); 19–20 fathoms; July 16, 1948. One specimen.

Note.—The single specimen is 38 mm. in diameter.

Palaeopneustidae

Homolampas fragilis (A. Agassiz)

Lissonotus fragilis A. Agassiz, Bull. Mus. Comp. Zool. **1**: 273. 1869.

Locality.—*Atlantis* cruise 152, station 20; north of the Azores (lat. 37° 50′ 30″ N., long. 26° 00′ W.); 1,400 fathoms; August 18, 1948. Fragments of 2 medium-sized specimens, one living and one dead.

CRINOIDEA

Bourgueticrinidae

Democrinus parfaiti E. Perrier

Democrinus parfaiti E. Perrier, Comptes Rendus **96** (7): 450. 1883.

Locality.—*Atlantis* cruise 152, station 11; north of the Azores (lat. 42° 53′ 30″ N., long. 29° 05′

W.); 720 fathoms; August 10, 1948. One specimen, without arms.

Notes.—This specimen consists of a root, stem, basals, and radials. The stem is about 105 mm. long with 55 columnals, and the basals are 3 mm. long.

BATHYCRINIDAE

Bathycrinus aldrichianus Wyville Thomson

Bathycrinus aldrichianus Wyville Thomson, Journ. Linn. Soc. (Zool.) **13**: pp. 47–51, fig. 1. 1876.

Bathycrinus serratus A. H. Clark, Proc. U. S. Nat. Mus. **34**: 205, fig. 1; 306. 1908.

Locality.—Between North Carolina and the Azores (lat. 34° 53′ N., long. 46° 24′ W.); 2,530 fathoms; September 3, 1948. One stem without the proximal portion, and fragments of another.

Notes.—The larger fragment is about 122 mm. long with 61 columnals, tapering to a diameter of 0.4 mm. at the broken proximal end. The longest columnals, near the broken end, are 1.5 mm. long and about four times as long as broad, and are cylindrical. The other smaller fragments are from a considerably stouter stem.

Prof. Torsten Gislén has suggested to me that my *Bathycrinus serratus* described in 1908 from *Albatross* station 2226, off Virginia in 2,045 fathoms, and recorded from *Albatross* station 2713, off Maryland in 1,859 fathoms, is in reality a synonym of Prof. Wyville Thomson's *B. aldrichianus*. With this suggestion I am quite in agreement.

LIST OF THE STATIONS, WITH THE SPECIES FOUND AT EACH

Station 1; south of Nantucket (lat. 40° 50′ N., long. 70° 10′ W.); 19–20 fathoms; July 16, 1948:

Echinarachnius parma

Station 6; east of southern Newfoundland and south of Cape Farewell, Greenland (lat. 47° 08′ N., long. 44° 52′ W.); 85 fathoms; July 31, 1948:

Leptychaster arcticus
Hippasteria phrygiana
Poraniomorpha borealis
Henricia sanguinolenta
Pteraster militaris
Asterias vulgaris
Ophiopholis aculeata
Ophiura sarsii
Ophiocten sericeum

Station 8; west of Newfoundland and south of Greenland (lat. 47° 10′ N., long. 36° 00′W.); 2,300 fathoms; August 2, 1948:

Dytaster biserialis
Henricia lisa
Freyella abyssicola
Amphiophiura convexa
Ophiura irrorata

Station 11; north of the Azores (lat. 42° 53′ 30″ N., long. 29° 05′ W.); 720 fathoms; August 10, 1948.

Ophiactis abyssicola
Ophiura ljungmani
Democrinus parfaiti

Station 20; west of San Miguel, Azores (lat. 37° 50′ 30″ N., long. 26° 00′ W.); 1,400 fathoms; August 18, 1948:

Dytaster mollis
Hydrasterias ophidion
Homolampas fragilis

Station 26; southwest of the Azores (lat. 34° 12′ 30″ N., long. 30° 12′ 30″ W.); 570 fathoms; August 26, 1948:

Ophiacantha abyssicola

Station 28; southwest of the Azores (lat. 34° 50′ N., long. 39° 20′ W.); 1,770 fathoms; August 30, 1948:

Plutonaster notatus

Station 30; between North Carolina and the Azores (lat. 34° 53′ N., long. 46° 24′ W.); 2,530 fathoms; September 3, 1948:

Amphiophiura convexa
Bathycrinus aldrichianus

Station BT 65; 200 meters:

Strongylocentrotus dröbachiensis

ORNITHOLOGY.—*A new race of bird of the genus* Spodiornis *from Venezuela.*

ALEXANDER WETMORE and WILLIAM H. PHELPS, JR.

The curious avian species *Spodiornis rusticus*, at present placed in the family Fringillidae, is of scattered and erratic distribution in Central and South America from the mountains of eastern Veracruz in México south to northern Bolivia. In Venezuela it has been known from 10 skins of *Spodiornis rusticus rusticus*, the typical race, collected on Cerro del Avila in the mountain near

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[1] Received August 19, 1949.

Caracas. A specimen taken by the junior author on Cerro Chimantá-tepui in the Guayana Highlands of Venezuela, south of the Río Orinoco, has been of especial interest for its extension of the known range to an isolated locality. After careful study we have determined this to represent an unknown form, and present its description.

Spodiornis rusticus arcanus, n. subsp.

Characters.—Similar to *Spodiornis rusticus rusticus* Tschudi[2] but blacker, more sooty gray above, and darker below.

Description.—Type, Phelps Collection no. 36,128-A, male, taken at 1,850 meters elevation near the summit on the western side of Cerro Chimantá-tepui, Estado Bolívar, Venezuela, July 13, 1946, by W. H. Phelps, Jr.; on deposit in the United States National Museum. Above blackish slate, shading to dark neutral gray on the sides of the head and rump; below neutral gray, with a slight amount of dull white in the center of the abdomen, and as edging on the larger under tail coverts; rectrices and remiges slate-black. Iris brown, maxilla black, mandible gray, tarsus brown (in life).

Measurements.—Wing 70.8, tail 46.5, culmen from base 12.1 (approximate), tarsus 19.5 mm.

Range.—Known only from the type locality near the summit of Cerro Chimantá-tepui, southeastern Bolívar, Venezuela.

Remarks.—The type, the only individual seen, was collected in low bushes near the summit of Chimantá-tepui, which is a table-top mountain of sandstone, with an area of more than 400 square miles, and an elevation of about 2,000 meters, located in the western part of the Gran Sabana region of southeastern Venezuela. The locality where the bird was found is covered with dense, subtropical plant growth, so that it is likely that the main part of the range of the form is found across the summit, where the cover of smaller trees and bushes is more open. No *Spodiornis* has been taken on the 14 other great sandstone mountains where collections have been made to date in the vast Guayana Highlands, between Roraima and Uei-tepui, on the British Guiana border, and Duida and Paraque in the region of the upper Orinoco.

The type specimen is unique but differs so definitely from a fair series of the typical form that there is no hesitance in allocating it a new name. The tip of the maxilla is broken, causing the bill to appear blunt, which serves to change the appearance of the head considerably, as these birds have sharply pointed bills. By chance the tongue has remained in place, its tip, under low magnification, being distinctly brushlike. It seemed at first that the whole tongue was fringed, but careful cleaning revealed that the fimbriate area was confined to the tip instead of continuing down the sides as at first supposed. The sharply pointed rectrices with the inner web cut away at the tip, a character of the genus *Spodiornis*, are peculiar. While placed in the Fringillidae it may be observed that the form of the tail and of the tongue suggest affinities with the Coerebidae, which in fact is the family in which P. L. Sclater originally described *Spodiornis*. A further unusual character is the posterior lengthening of the gonys so that the gonydeal angle is at the level of the posterior margin of the nasal fossae, instead of well anterior to that point as is usual in Fringillidae.

The latest treatment of *Spodiornis*, that of Hellmayr,[3] recognizes three subspecies to which the present description adds a fourth. *Spodiornis rusticus barrilesensis* Davidson, of Costa Rica, and Chiriquí in western Panamá, has a slightly larger bill, and while somewhat darker than *rusticus* is definitely lighter, less sooty gray, than *arcanus*. *S. r. uniformis* from near Jalapa, Veracruz, which has not been available for examination, is described as being larger, but the difference from *barrilesensis* seemingly is slight. According to Ridgway[4] the wing measures 76 mm, whereas Hellmayr gives it as 75 mm.

Material available for comparison (adult males only) has been as follows:

Spodiornis rusticus rusticus: ECUADOR: Sumaco Arriba, Quito, below Calacali. COLOMBIA: Cachirí and Buenos Aires, Province of Santander del Norte.

Spodiornis rusticus barrilesensis: COSTA RICA: Carrillo and Navarro.

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[2] *Phrygilus rusticus* Tschudi, Arch. Naturg. **10** (1): 290. May 1844. (Perú.)

[3] Cat. Birds Amer., Field Mus. Nat. Hist., zool. ser., **13** (pt. 11): 369–371. 1938.

[4] U. S. Nat. Mus. Bull. **50** (pt. 1): 521. 1901.

HERPETOLOGY.—*A new frog of the genus* Batrachylodes *from the Solomon Islands.*[1]

WALTER C. BROWN AND GEORGE S. MYERS, Natural History Museum, Stanford University. (Communicated by HERBERT FRIEDMANN.)

In this paper we present the description of a very distinctive and beautiful little frog from the Solomon Islands, representing the second known species of the hitherto monotypic genus *Batrachylodes*. We are indebted to Miss Doris M. Cochran, of the U. S. National Museum, for the loan of the material upon which the new species is based, and to Walter L. Necker, who is working on Solomon herpetology, for his generosity in relinquishing claim to describe a new form which he himself collected.

In 1887 (p. 337) Boulenger described *Batrachylodes*, a new genus of Ranidae, on the basis of a single adult female from Faro (Fauro) Island, Solomons. This genus was defined as lacking vomerine teeth; tongue free posteriorly and only feebly indented; pupil horizontal; fingers and toes free, with large terminal disks; outer metatarsals united; omosternum and sternum with a bony style. As pointed out by Noble (1931, p. 524), the genus is apparently allied to *Cornufer* in the forked omosternum, though the opening is very small, and in the prominent digital disks. It differs in the absence of webs, vomerine teeth, and the transverse groove on the lower surface at the base of the disks. Sternfeld (1920, p. 435, pl. 31, figs. 8, 9) described and illustrated *Chaperina friedericii* and *Sphenophryne wolfi* from Buka Island, Solomon Islands. Both of these were later placed in the synonymy of *Batrachylodes vertebralis* Boulenger by Mertens (1929, pp. 266–268). Comparison of the descriptions and illustrations in Sternfeld's paper with the specimens before us indicates that Mertens was correct in his decision and that the present series of specimens represents an heretofore undescribed species.

Batrachylodes trossulus, n. sp.

Holotype.—U.S.N.M. no. 119577, adult male, collected at Torakina, Bougainville Island, Solomon Islands, by Walter L. Necker.

Paratypes.—Six specimens, U.S.N.M. nos. 119586–88 and 119787–89, from the type locality.

Definition.—A small *Batrachylodes* with disks of fingers round, scarcely dilated, swollen, and much smaller than those of the toes; disk of the third finger much smaller than the tympanum; forelimb and fingers very slender; lateral surface of the head and body black, this color fading out in the region of the groin but reappearing as an irregular dark bar on the inner side of the femur; ventral surface of head, throat, and pectoral region dusky red-brown (in preservative), occasionally spotted with white; the dark color extending as a diagonal bar from the shoulder across the upper arm.

Description of holotype.—Head narrow; snout moderately pointed, strongly projecting beyond the lower lip; chin with numerous small, white, hard, nuptial tubercles; vomerine teeth not present; tongue narrowly oval, not notched at the posterior free margin; nostril about equidistant from the tip of the snout and the anterior angle of the eye.

Forelimb moderately developed; fingers with swollen, round disks only slightly dilated at tip; diameter of disk of third finger about half that of tympanum; first finger not reaching the distal joint of second finger; subarticular tubercle poorly developed; inner and middle metacarpal tubercles broadly oval and moderately developed; outer somewhat smaller and not well developed; a fourth rounded tubercle occurring just posterior to the middle one and extending out beyond the inner edge of the outer one.

Tibiotarsal articulation reaches eye when hindlimb is appressed; toes without web, rather broadly expanded at the tips; disks much larger than those of fingers; subarticular tubercles moderately developed; inner metatarsal tubercle oval, elongate, its length equal to its distance from the tip of the fifth toe; outer metatarsal tubercle moderately distinct, round.

Skin smooth both above and below, and on limbs.

Color.—Dorsum gray with a tinge of pale reddish and suffused with dusky, particularly on the head; sides of head and body black with

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[1] Received July 14, 1949.

a rather even, light-bordered, dorsal edge except on the posterior abdomen where the black color gradually disappears, reappearing as an uneven-margined, dark-brown or blackish bar on the outer surface of the thighs (when the hind limbs are extended) and as a very irregular or broken line on the outside of the lower leg; upper surfaces of the hindlimbs marked with rather narrow grayish-brown bands; belly white with a few brown spots; ventral surface of head, throat and pectoral region dark reddish brown with a few scattered small white spots in addition to the white tubercles of the chin region; darker along the lateral margins and continued as a broad irregular stripe on the anterior side of the upper and lower arm and the dorsal surface of the hand, and with a similar broad blackish stripe on the posterior side of the limb, not continuing on the palm, however; posterior proximal areas of thighs and anal region black.

Measurements of holotype (in millimeters).—Snout to vent 20, snout 3, diameter of eye 3, diameter of tympanum 1.65, length of hindlimb 30, breadth of head 6.5, length of tibia 10.

Variations and remarks.—Whereas *Batrachylodes vertebralis* from this same locality, Bougainville Island, shows much variability in both dorsal and ventral coloration, the seven specimens of *trossulus* are remarkably constant. The largest female (U.S.N.M. no. 119586) measures slightly less than 20 mm from tip of snout to vent; the smallest specimen (U.S.N.M. no. 119788), 14 mm. The small white nuptial tubercles on the chin and undersurface of the head of males also occur on the males of *B. vertebralis* from Bougainville and Ronongo Islands, which we have available for comparison.

A single specimen from Choiseul Island, Amer. Mus. Nat. Hist. no. 35425, is assigned to this species, which it fits very well on the basis of the digital disks. However, in its present poor condition, it does not show the distinctive color pattern so evident in all the specimens of the series from Bougainville. This specimen was originally referred to *Rana solomonis* by Burt and Burt (1932, p. 491).

The two species of *Batrachylodes* may be distinguished as follows:

1. Disks of fingers rounded, little dilated, scarcely or not at all flat-tipped, smaller than those of toes; breadth of disk of third finger about half diameter of tympanum or less; throat and chest dark; posterior to this undersides of belly and thighs white; sides of body covered by a wide blackish band almost to groin, on all Bougainville examples seen (one from Choiseul doubtful); a smaller and apparently a less variable species than next....*B. trossulus*
2. Disks of fingers broadly dilated, broadly elliptical, almost flat-tipped, larger than those of toes; breadth of disk of third finger about equal to or greater than diameter of tympanum; undersides of body with a variable dusting of dark chromatophores, never as in previous species; sides of body usually with an indistinct dark area on sides of head often continued back a little way behind head, never a wide black band; a larger and more variable species than preceding.........*B. vertebralis*

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PROCEEDINGS OF THE ACADEMY

430TH MEETING OF BOARD OF MANAGERS

The 430th meeting of the Board of Managers, held in the Cosmos Club, September 19, 1949, was called to order at 8:05 P.M. by the President, F. H. H. Roberts, Jr. Also present were: F. B. Silsbee, H. S. Rappleye, N. R. Smith, Alan Stone, F. M. Defandorf, C. L. Gazin, F. E. Johnston, C. F. W. Muesebeck, F. A. Weiss, W. A. Dayton, C. A. Betts, A. O. Foster, Margaret Pittman, H. W. Hemple, H. G. Dorsey, F. M. Setzler, and, by invitation, Herbert Friedmann, J. E. Graf, M. A. Mason, and L. W. Parr.

The President announced the appointment on June 14 of Frank Thone and Paul H. Oehser to represent the Academy on the Committee for the Science Calendar. Owing to the death of William J. Rooney, Fred L. Mohler was appointed Chairman of the Physical Sciences Committee on Awards for Scientific Achievement, and

Frank C. Kracek was appointed as a member to fill the vacancy.

The Chairman of the Committee on Meetings, **Herbert Friedmann**, reported on programs arranged for the October, November, and December meetings. He raised the question as to the Board's desire concerning the annual meeting of the Academy next January. The Board recommended that the Committee arrange to have a dinner together with a speaker, similar to the January 1949 meeting.

The Committee on Membership submitted the names of nine individuals for resident membership in the Academy.

The Chairman of the Committee on Encouragement of Science Talent, **M. A. Mason**, reported that an agreement had been signed with Science Service to participate in the forthcoming annual science talent search. The Secretary read a letter from John R. McGonegal, a recipient of one of the Academy's Certificates of Merit for last year, indicating that he had been awarded a 4-year Scholarship in the School of Engineering at Catholic University and expressing his appreciation to the Academy for recommending him.

The Secretary read a letter from Frank Thone dated July 15, 1949, in which he reviewed the action of the Committee on Health and Research, which he attended as an observer for the Academy.

The Secretary announced the following deaths: **H. M. Goodwin**, physicist, Massachusetts Institute of Technology, Cambridge, Mass., on June 26, 1949 (elected May 17, 1915); **Charles J. Brand**, agriculturist, Washington, D. C., on June 29, 1949 (elected January 18, 1912); **P. G. Nutting**, physicist, formerly with the U. S. Geological Survey, on August 8, 1949 (elected January 18, 1912; resigned October 13, 1915; reelected December 22, 1924; on retired list December 31, 1943); **Frank E. A. Thone**, botanist, Science Service, on August 25, 1949 (elected December 1, 1939); and **William J. Rooney**, physicist, Department of Terrestrial Magnetism, Carnegie Institution of Washington, on August 31, 1949 (elected June 19, 1930).

The Senior Editor, **Alan Stone**, reported that for the first six months the net cost of the Journal, after deducting charges to authors, was $3,013.41, or well within half of the budget allotment for the year. These first six numbers amounted to 216 pages, an average of 36 pages per issue, slightly less than for the past two years.

There was considerable discussion on matters covered in the report on "Means of Raising Additional Funds for the Academy" by the Committee on Policy and Planning. The Board suggested that the President meet with the Committee on Membership to determine a possible solution to some of the problems confronting this Committee. As to the acceptance of advertising in the Journal, the Chairman of the Committee, **J. E. Graf**, indicated that, to judge from a conversation he had with the editor of one of the chemical journals, the Academy could expect only a slight income from this source. With regard to reduction in size of the Journal, the Board directed that a committee be appointed by the President to look into the cost of the offset printing method and the formulation of an editorial policy for the Journal, and to make a recommendation to the Board. If necessary, this committee should be permitted to make a survey of the Academy membership for its reactions. The Board accepted the report on "Means of Raising Additional Funds for the Academy" and expressed its gratitute to the Committee for the amount of work involved.

The meeting adjourned at 11:07 p.m.

F. M. Setzler, *Secretary.*

Obituary

Edward Rhodes Stitt, honorary member of the Washington Academy of Sciences, died on November 13, 1948, in the Naval Medical Hospital, Bethesda, Md. He was laid to rest with full military honors in Arlington National Cemetery on November 16. At the time of his death he was still, at the age of 81, a commanding figure in the field of tropical medicine, a field in which he had been active for more than 40 years.

Admiral Stitt was born in Charlotte, N. C., on July 22, 1867. After receiving his A.B. degree from the University of South Carolina in 1885, he entered the University of Pennsylvania, where he studied under William Osler and received his M.D. degree in 1889. He accepted a commission in the Medical Corps of the Navy soon after graduation and during the next four years saw duty on several naval ships and at the Naval Hospital in Norfolk, Va.

In August 1896 he reported to the Bureau of Medicine and Surgery, where he served during the Spanish American War. No doubt his great interest in tropical medicine was stimulated by the responsibility of rendering medical service to people in the Tropics which fell on the Medical Department of the Navy when Guam, the Philippines, Puerto Rico, and Cuba became wards of the United States after the Spanish American War.

In 1902 Admiral Rixey, then Surgeon General of the Navy, succeeded in having the Naval Observatory building at the foot of Twenty-fourth Street, NW., in Washington, D. C., turned over to the Medical Department of the Navy, and plans were laid for the Naval Medical School and a new hospital. Admiral Stitt was selected to head the bacteriological, chemical, and tropical disease departments. Admiral Rixey wrote: "His selection for the work was most fortunate as few mistakes were made and from the beginning his energy and equipment for the work relieved me of an immense amount of embarrassment."

As medical officer of the Nicaraguan Canal Commission in 1895, Admiral Stitt reported on the many, though not serious, health problems encountered and the outlook for protecting troops guarding the canal after its construction. He was ordered to London in 1905 to study tropical medicine under Sir Patrick Manson, of the London School of Tropical Medicine. Following his graduation, with distinction, from that institution, he continued his investigation of tropcial diseases in the Philippines, Guam, Japan, and Hawaii.

In 1911 Admiral Stitt completed a 2-year tour of duty as medical officer in command of the United States Naval Hospital, Cañacao, Philippine Islands, and returned to United States as medical inspector for duty in the Bureau of Medicine and Surgery and the United States Naval Medical School in Washington, D. C. His excellent training, rich experience, and ability as a teacher contributed materially to the world reputation gained by the Naval Medical School in the field of tropical medicine.

On September 18, 1916, he assumed command of the Naval Medical School and served in that capacity during World War I with the rank of rear admiral. His military duties did not prevent him from contributing to the training of Medical men not yet in the Service, for he served as professor of tropical medicine at Georgetown University and George Washington University in Washington, D. C., and as lecturer in that subject at the Jefferson Medical College in Philadelphia.

Admiral Stitt was appointed Surgeon General of the Navy and chief of the Bureau of Medicine and Surgery by President Woodrow Wilson and assumed those duties on November 30, 1920. President Calvin Coolidge appointed him to those positions for another 4-year term in 1924. Upon completion of this term he became inspector of Medical Department activities in the Eleventh Naval District with headquarters at San Diego, Calif.

Admiral Stitt contributed numerous articles in the fields of bacteriology, parasitology, and hospital administration, but he is most widely known by his textbooks *Practical bacteriology, haematology and parasitology* and *Diagnosis, prevention, and treatment of tropical diseases*. The popularity of these texts is attested by the fact that the first is now in its tenth and the second in its seventh edition.

Several institutions conferred honorary degrees on Admiral Stitt, and the Navy Cross was awarded him for "exceptional meritorious service" during World War I. He was a member of numerous medical and scientific associations, including the American College of Surgeons, the American Medical Association, the Association of American Physicians, the American Society of Tropical Medicine (president 1912), the American Association of Military Surgeons (president 1925, 1926), and the Royal Society of Medicine, and honorary member of the Washington Academy of Sciences.

Although Admiral Stitt was transferred to the retired list of the Navy on August 1, 1931, he continued to participate in many scientific and medical activities. He served as consultant to the Secretary of War during World War II and was on the Board of Directors of the Gorgas Memorial Institute of Tropical and Preventive Medicine and of Walter Reed Memorial Association.

Admiral Stitt was the son of William Edward and Mary Rhodes Stitt. He is survived by his widow, Helen Bennett (Newton) Stitt, one son, Commander Edward W. Stitt, USNR, of Trenton, N. J., and two daughters, Mrs. Warren Stephenson, of Washington, D. C., and Mrs. Herman Hudgins, of Norfolk, Va., and six grandchildren.

The regard in which Admiral Stitt was held by all his associates was well expressed by Admiral Pugh when he accepted, for the Naval Medical School, a portrait of Admiral Stitt and referred to him as "the Naval Medical Corps' premier doctor, scientist, author, scholar, officer, and gentleman."

F. C. Bishopp.

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JOURNAL
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VOLUME 39 DECEMBER 15, 1949 No. 12

BOTANY.—*Cortical tracheids in the African cherry oranges* (Citropsis *species, Rutaceae: Aurantioideae*).[1] FRANK D. VENNING, University of Miami. (Communicated by WALTER T. SWINGLE.)

The African cherry oranges belong to the genus *Citropsis* and are small-fruited trees or shrubs rather closely related to the genus *Citrus* and even more closely related to *Atalantia* (Swingle and Kellerman, 1914). At the present time 11 species and 1 variety of *Citropsis* are known, ranging across tropical and subtropical Africa from Sierra Leone to Angola on the west coast and from Uganda south to Mozambique in East Africa, as well as in the regions of central Africa lying between (Swingle, 1943). Horticulturists and citrus growers will be interested in the African cherry oranges because of their ability to graft with and support *Citrus*. Gillet's cherry orange, *Citropsis gilletiana*, which makes a sizable tree up to 35 feet high, is the only rootstock that has been used successfully for *Citrus* at the Eala Botanic Garden in the Belgian Congo, where it has been employed on a fairly large scale for all the common species of *Citrus*. It has proved to be immune to the attack of a longicorn beetle very destructive to most *Citrus* rootstocks. Tests of other species of *Citropsis* as *Citrus* rootstocks are also being conducted by the Eala garden (Goossens, 1924; Staner, 1929; Pynaert, 1935; Fawcett, 1936).

Plant anatomists and histologists, no less than horticulturists, will find *Citropsis* an interesting genus because of the abundance of cortical tracheids which accompany or supplement the regular vascular supply in the flowers and fruits. These tracheids, unlike the regular elements of the vascular system, are derived from highly vacuolate cortical parenchyma of the pedicel and receptacle and from the "ground parenchyma" of the floral organs. The individual tracheids usually retain the approximate isodiametric shape of the original parenchyma cell but develop highly lignified reticulate thickenings of the cell wall, after which the protoplast disintegrates. They are of quite general occurrence under many circumstances in plants of the orange subfamily. Their ontogeny has been described in detail in a separate paper (Venning, 1946), and further instances of their occurrence reported for several species of the genus *Citrus* (Venning, 1947).

The present survey determines in which floral organs and under what conditions cortical tracheids occur in all available species of the genus *Citropsis* and discusses their possible functions, together with their application as taxonomic characters.

I express my great indebtedness to Dr. Walter T. Swingle, director of the research project that undertook this study, for providing through his resources much material that would otherwise have been unobtainable. My indebtedness is also expressed to the Science Research Council of the University of Miami, under whose sponsorship the work was conducted.

MATERIALS AND METHODS

Mature flower buds were used for this study. Fresh flowers and flower buds of *Citropsis gilletiana* Swing. and M. Kell. were collected from a plant growing at the U. S. Department of Agriculture's Plant Introduction Garden at Chapman Field, Fla. Similar material of *C. schweinfurthii* (Engl.) Swing. and M. Kell. was obtained from plants growing in the U. S. Department of Agriculture's Citrus greenhouse at Glen

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Dale, Md. *C. zenkeri* Engler was represented by one flower bud and three small pistils, secured for study from two herbarium sheets of this species in the herbarium of the Museum de Paris by Dr. Walter T. Swingle. Mature flower buds of *C. angolensis* Excell, *C. articulata* (Wild.) Swing. and M. Kell., *C. mirabilis* (A. Chev.) Swing. and M. Kell., *C. latialata* (De Wild.) Swing. and M. Kell., *C. gabunensis* (Engl.) Swing. and M. Kell., *C. le-testui* Pellegrin, and *C. tanakae* Swing. and M. Kell. were obtained from herbarium specimens of these species by Dr. Walter T. Swingle, who also arranged the loan of the slides of the herbarium material from the Department of Agriculture. These slides were made by Dr. Albert H. Tillson, who was formerly employed as an assistant to Dr. Swingle. Of *Citropsis gabunensis* var. *lacourtiana* (De Wild.) Swing. and M. Kell., no flower buds were available, but a herbarium specimen of a flower from which the petals and stamens had just recently abscissed was secured by Dr. Swingle. The data for *C. gabunensis* var. *lacourtiana* is therefore not complete so far as the tissues of the petals and stamens are concerned, but the data that could be secured from this pistil are included here because it showed differences from the other species. No material of *C. dawecna* Swing. and M. Kell., a little-known species, was available.

The fresh material of *C. gilletiana* and *C. schweinfurthii* was fixed in 70 per cent formalin-aceto-alcohol, washed in water, dehydrated with a tertiary butyl alcohol series and imbedded in Fisher Tissuemat.

The herbarium material was restored by the technique developed by Juel (1918) and modified by Dr. Swingle, dehydrated in an ethyl alcohol series, and also imbedded in Tissuemat.

Transverse and longitudinal serial sections of both groups of specimens were made on a rotary microtome at 10, 12, and 15 microns when the material permitted. In several instances only one flower was available from the herbarium material; in these cases only transverse serials were made. The slides were stained with safranin and fast green, and permanently mounted. With the exception of the slides loaned from the U. S. Department of Agriculture, they are permanently filed in the Tropical Histological Research Collection of slides at the University of Miami.

From these flower buds of nearly the same age and same stage of development, the occurrence of cortical tracheids in relation to the main vascular system was determined in all floral organs.

OBSERVATIONS

Location of the cortical tracheids in Citropsis.—As with the other genera of the orange subfamily which develop these structures, cortical tracheids are found in three locations in relation to bundles of the main vascular system: (1) Laterally adjacent to the typical xylem of the true vascular bundles, (2) extending beyond the xylem of the regular vascular bundles, and (3) as independent strands of tissue apart and seemingly independent from the main vascular system.

Only two species, *Citropsis mirabilis* and *C. tanakae*, develop cortical tracheids in the pedicels. In *C. tanakae* these were isolated strands of tracheids in the upper portion of the pedicellar cortex. *C. mirabilis* also developed isolated strands of tracheids in the upper portion of the pedicel, which often extended unbroken on up into the enlarged

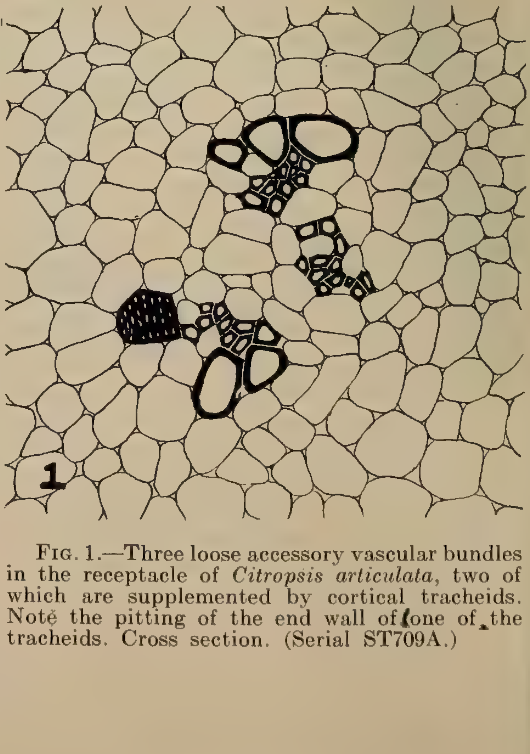

Fig. 1.—Three loose accessory vascular bundles in the receptacle of *Citropsis articulata*, two of which are supplemented by cortical tracheids. Note the pitting of the end wall of one of the tracheids. Cross section. (Serial ST709A.)

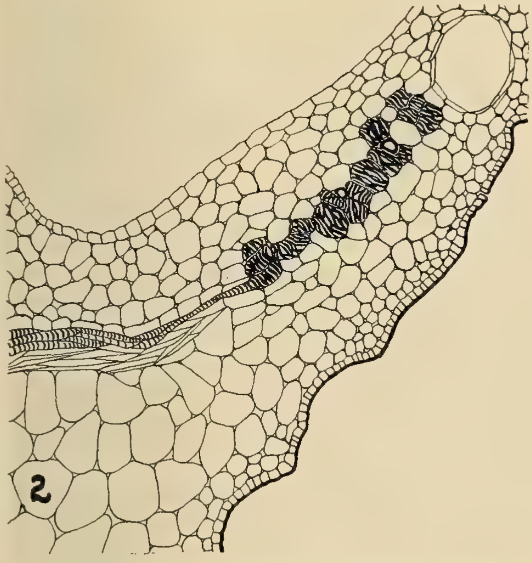

Fig. 2.—Cortical tracheids extending from the termination of a lateral sepal bundle nearly to the tip of the sepal. These tracheids actually form a continuous column, but because of their irregularity the column appears broken in the figure. From *Citropsis mirabilis*, longitudinal section. (Serial ST274B.)

receptacle. In addition, pedicels of this species have loose accessory bundles similar to those described for *Murraya* and *Citrus* (Venning, 1945, 1947), and the xylem of these bundles is often flanked by tracheids derived from cortical parenchyma.

In the receptacle, all the species have some of the regular vascular bundles accompanied by cortical tracheids, and all with the exception of *C. latialata* have the xylem of the vascular bundles extended by cortical tracheids in this region. *Citropsis articulata*, *C. mirabilis*, *C. gilletiana*, and *C. zenkeri* have accessory bundles in the receptacle, and these are flanked by cortical tracheids (Fig. 1). In *C. mirabilis* and *C. zenkeri* the accessory bundles are extended by cortical tracheids. In addition, *Citropsis articulata*, *C. mirabilis*, *C. gilletiana*, *C. gabunensis*, *C. zenkeri*, *C. le-testui*, and *C. tanakae* have independent strands of cortical tracheids in the receptacle, usually about halfway between the epidermis and the stele.

The calyx presents a similar pattern for all species, with both the midrib and lateral sepal bundles accompanied and extended by cortical tracheids (Fig. 2).

With the bundles of the corolla, no cortical tracheids were observed accompanying the vascular bundles, but they were observed as extensions of the bundles in five species, all members of the subgenus *Eucitropsis: C. schweinfurthii*, *C. angolensis*, *C. mirabilis*, *C. gilletiana*, and *C. latialata* (Fig. 3).

The vascular supply to the stamens is not supplemented by cortical tracheids, and none was observed in the male parts of any of the flowers.

The base of the ovary rests on a conspicuous glandular disk, and in *Citropsis articulata* and *C. latialata* a few cortical tracheids were found in this region as independent strands of tissue. In *C. latialata* they occasionally accompanied the main vascular supply to the disk.

In the ovary proper, *Citropsis zenkeri* and *C. tanakae* were the only species to differentiate cortical tracheids. In *C. zenkeri* they consisted of a few independent strands near the top of the ovary, in close proximity to the huge oil glands which develop there. In *C. tanakae* they were found as independent strands in the carpel wall, and a few were seen accompanying the lateral carpel bundles (Fig. 4).

Only *Citropsis articulata* had cortical tracheids in the style; these were in the upper

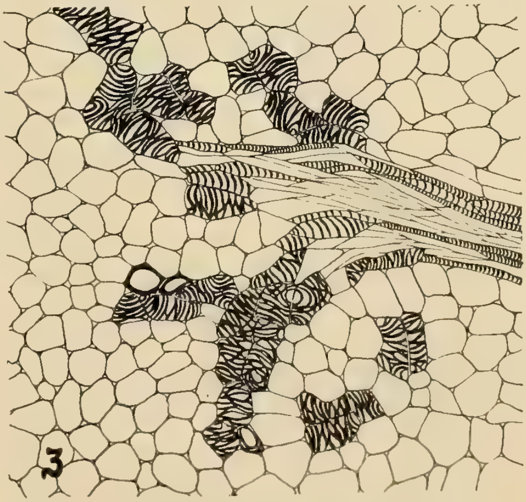

Fig. 3.—Cortical tracheids extending beyond the termination of the true vascular elements in a petal midrib bundle of *Citropsis gilletiana*. Note the general shape and size of these tracheids as compared to the adjoining "ground parenchyma" cells of the petal, and also as compared to the xylem in the vascular bundle. Longitudinal section. (Serial SV423B.)

part near the base of the stigma, and consisted of independent strands, also as an accompaniment to the regular vascular bundles, and as extensions to the minor veins.

Cortical tracheids in the stigma were found in *Citropsis angolensis*, *C. gabunensis* var. *lacourtiana*, and *C. zenkeri*. In *Citropsis angolensis* there were independent strands, as well as extensions of the regular bundles (Figs. 5, 6); *C. gabunensis* var. *lacourtiana* and *C. zenkeri* had no independent strands.

The position of cortical tracheids in the flowers of the species of *Citropsis* studied is presented in tabular form in Table 1 for ready comparison between the species.

DISCUSSION

The use of cortical tracheids in the taxonomy of Citropsis.—As Tillson and Bamford (1938) have described, the members of the genus *Citropsis* all have the floral vascular bundles in an identical arrangement, with the exception of *C. gabunensis*. In this species the dorsal carpel bundles, instead of extending up the style, terminate at the top of the ovary. Tillson and Bamford were only interested in the course or pattern of the floral vascular bundles, and evidently took no notice of the elements from which the bundles were composed. As can be seen from Table 1, all 10 of the species of *Citropsis* included in this study showed distinct differences from one another in the location and position of cortical tracheids in relation to the main vascular elements. Thus they become a character which can be used to help distinguish between similar species or varieties.

If this character be employed taxonomically, care must be taken to see that the material to be compared is at approximately the same stage of development. Studies of flower buds, flowers, and young and more mature fruits of *Citropsis gilletiana* have shown that the number and location of cortical tracheids changes as the flower bud matures, and as the pistil develops. For example, flower buds and flowers of this species have developed no cortical tracheids in the pistil, but as the fruit develops great numbers of cortical tracheids are differentiated in the outer carpel wall. However, it has also been seen that the location of cortical tracheids does not vary between individual flowers, flower buds, or fruits of a given species at a specific stage of development. They therefore become a valid and useful character if the above-mentioned precaution is observed.

Functions of the cortical tracheids in Citropsis.—The limited number of the elements in the main vascular system, which are differentiated from procambial strands originated by the floral meristem, suggests that cortical tracheids, when found in conjunction with the elements of the main vascular system, function as supplementary organs of water conduction. By far the largest number of cortical tracheids occurs in the receptacle and calyx of flowers of this genus, and they are first differentiated in these floral parts. Young flower buds have lateral sepal bundles which contain only a few xylem strands. The lateral sepal bundles arch outward and upward from the stele across the cortex of the receptacle and usually terminate in the lower third of the sepal. There is no procambial strand above the point of termination. Sections of older flower buds or flowers reveal that the number of true xylem elements within the lateral sepal bundles has remained the same, although the sepal may have doubled in size. At this stage of development the xylem of the lateral sepal bundles is invariably flanked with cortical tracheids, from the point of divergence at the stele to their termination in the lower

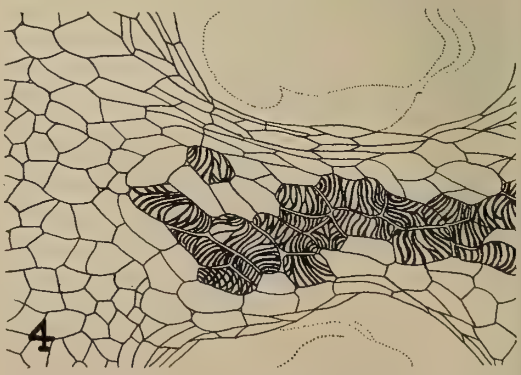

Fig. 4.—Cortical tracheids extending from the top of a lateral carpel bundle up between two oil glands in the stigma of *Citropsis angolensis*. Longitudinal section. (Serial ST273A.)

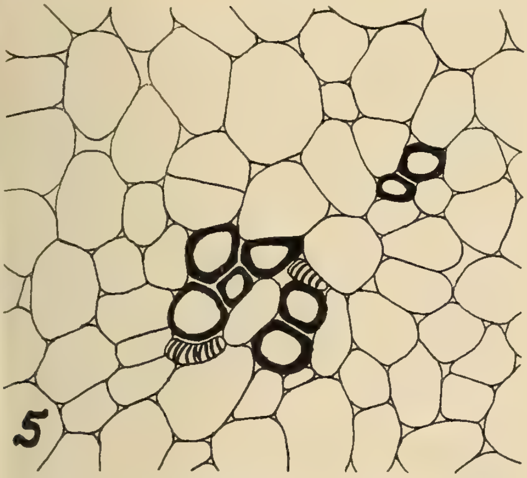

Fig. 5.—An independent strand of cortical tracheids from the stigma of *Citropsis angolensis*. Cross section. (Serial ST273A.)

portion of the sepal. Above the true vascular bundle, long irregular columns of cortical tracheids, developed from the vacuolate "ground parenchyma" of the calyx, extend nearly to the sepal tip.

The sepal midribs on the average contain about 15 xylem elements near the base of the sepals, and this number gradually decreases to five or six elements at the middle of the sepal. Some true xylem elements of the sepal midrib extend into the upper third of the sepals. Here again, as the flower nears the time of blooming and the calyx has reached full size, cortical tracheids are developed in a sort of sheath around the upper portions of the sepal midrib, and also extend from the midrib nearly to the sepal tip.

The calyx of *Citropsis*, as with most aurantioid plants, is persistent after flowering and remains attached to the base of the mature fruits. It reaches its full size during the development of the flower bud and is fully developed when the flower opens. The true vascular elements of the calyx reach their complete differentiation when the flower buds are small. Although there is much secondary xylem derived from cambial activity in the main floral axis as the fruit enlarges, none of the bundles in the calyx or other parts of the flower, other than those of the ovary, develop any secondary elements; and are in effect "closed" bundles, with no cambial activity. The number of xylem and thin-walled elements differentiated within the bundles is entirely dependent on the amount of tissue that was in the procambial strands, which would seem to be insufficient for the increased volume of parenchyma in the mature calyx which must be supplied with adequate water.

Wylie (1939; 1946), who has done a vast amount of work on the organization of vascular to nonvascular tissues in the leaves of several hundred dicotyledons, has concluded that "the distribution of vascular strands in the leaf blade is influenced . . . by problems of transfer through the living tissues lying between the veins." Wylie has further suggested on the basis of his studies that a definite correlation exists between the amount and arrangement of non-vascular to vascular tissues in leaves. In other words, a given volume of a particular kind of parenchyma must have vascular strands at specific spacial intervals for adequate conduction. This concept would seem applicable to floral organs of *Citropsis*, and it seems probable where, for example, in the calyx only a limited quantity of vascular tissue of uncertain length is differentiated, that the "limit of correlation" is exceeded as the parenchymatous cells of the calyx continue to divide and expand, without the accompanying development of more vascular tissue. Hence, as the proportion of non-vascular to vascular tissue becomes too great, the

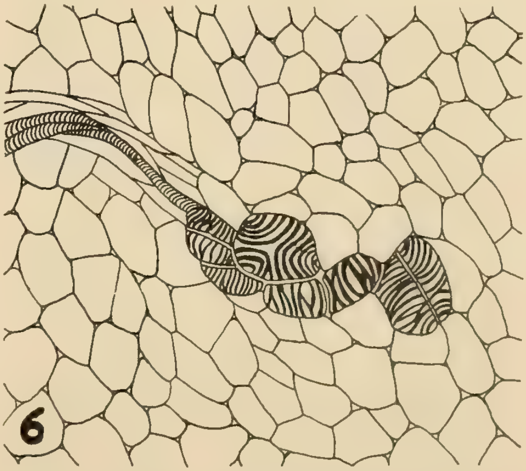

Fig. 6.—Cortical tracheids extending beyond a branch of a lateral carpel bundle in the ovary of *Citropsis tanakae*. Longitudinal section. (Serial ST226A.)

"ground parenchyma" is quickly differentiated into tracheids adjoining and extending the vascular bundles, and which to all appearances are capable of water conduction. It may also be significant that other genera in this subfamily which have large and abundant vascular bundles in relatively small floral organs, such as the genus *Severinia*, have never been observed to differentiate tracheids of this nature.

The independent groups or strands of cortical tracheids are less easily explained. These cells are not in any sense sclerides or stone cells, for they are identical to those associated with the regular vascular tissue, and have reticulate lignified bands on the walls; sometimes the end walls possess numerous simple pits instead of reticulate striations; this condition was also frequently seen for those accompanying the vascular strands. The cells, when fully differentiated, are clear and show no trace of cell contents. Such independent strands or groups of tracheids may serve as water storage tissue.

SUMMARY

Cortical tracheids, which develop from vacuolate cortical parenchyma, or "ground parenchyma" of floral organs and which have a different ontogeny from the true xylem elements, are described from the flowers of 10 of the 11 known species of *Citropsis*. In this genus cortical tracheids were found adjoining the true xylem of the vascular bundles, or as extensions of the vascular supply, or as strands of xylem independent of the main vascular system. They occurred in different circumstances and in different floral organs in each of the species, which makes them useful as an additional taxonomic character to help distinguish between the species. It is suggested that because of the limited number of xylem elements differentiated in the true vascular bundles, and the limited length of many of the vascular bundles, the cortical tracheids, when associated with the regular vascular supply, function in a water-conducting capacity.

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Table 1.—Distribution of Cortical Tracheids in the Genus Citropsis

Species	Pedicel	Receptacle	Calyx	Corolla	Disk	Ovary	Style	Stigma
Eucitropsis:								
1. C. schweinfurthii		4,5	4,5	5				
2. C. angolensis		4,5	4,5	5				3,5
3. C. articulata		1,3,4,5	4,5		3		3,4,5	
4. C. mirabilis	1,3	1,2,3,4,5	4,5	5				
5. C. gilletiana		1,3,4,5	4,5	5				
6. C. latialata		4	4,5	5	3,4			
Afrocitrus:								
7. C. gabunensis		3,4,5	4,5					
7a. C. gabunensis var. lacourtiana		4,5	4,5					5
8. C. zenkeri		1,2,3,4,5	4,5			3		5
9. C. le-testui		3,4,5	4,5					
Species of Uncertain Relationship:								
10. C. tanakae	3	3,4,5	4,5			3,4		
11. C. daweana	(No flowers available)							

Key: 1: Accompanying the accessory vascular bundles.
2: Extending beyond the xylem of the accessory vascular bundles.
3: Independent strands of tissue.
4: Accompanying the regular vascular bundles.
5: Extending beyond the xylem of the regular vascular bundles.

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ZOOLOGY.—*Three new species and one new variety of amphipods from the Bay of Fundy.*[1] Clarence R. Shoemaker, U. S. National Museum.

While studying the amphipod material from the Bay of Fundy, which has been sent to the United States National Museum for identification by the Biological Board of Canada, I noted three new species and one new variety. These are now being described and the types deposited in the National Museum of Canada, Ottawa, Ontario.

Haustoriidae

Bathyporeia quoddyensis, n. sp.

Figs. 1, 2

According to the key given by E. Emrys Watkin (*A revision of the amphipod genus* Bathyporeia *Lindström,* Journ. Mar. Biol. Assoc. United Kingdom **23** (1): 234. 1938), for the identification of the species of *Bathyporeia,* this species should be *B. pelagica.* While these animals from Passamaquoddy Bay possess the characters he assigns to *pelagica,* they also possess characters that apparently do not belong to *pelagica.* Believing that the characters foreign to *pelagica* are sufficiently pronounced for the establishing of a new species, I am naming it *Bathyporeia quoddyensis.* Females only have been taken.

Female.—The entire animal is heavily pitted, and this pitting can be easily seen when the animal is stained with a dark stain. Eye small, light reddish brown in alcohol, and consisting of about six facets. Antenna 1, first peduncular joint distally rounding, three closely set spinules on the upper, outer, proximal margin and about eight similar spinules continued along the upper margin and around the blunt distal end, a rounding protuberance bearing a few slender spines and three plumose setae at about the center of lower margin, a group of spines distally and three slender spines between the protuberance and end of joint; flagellum consisting of six joints; accessory flagellum without a tuft of setae on its outer margin. Antenna 2, fourth peduncular joint about twice as long as fifth; flagellum shorter than fourth and fifth peduncular joints combined and consisting of seven joints. Mouth parts about normal.

Gnathopod 1, coxal plate centrally constricted and expanded distally, lower and hind margins bearing a few spines; first joint equal in length to the fifth and sixth combined; sixth joint two-thirds the length of the fifth; seventh joint bears a seta proximally on the outer margin and a spinule distally on the inner margin. Gnathopod 2 much as figured by Chevreux and Fage (Fig. 86, gn. 2) for *pelagica,* but there are fewer spinules on lower margin of coxal plate, and the sixth joint is spatulate and not narrowly angular distally as shown in their figure. Peraeopod 1 is as shown by Fig. 2, *C,* the coxal plate bearing very few spines. Coxal plate 4 bears spines on lower margin and lower hind margin. Peraeopod 3 is as shown by Fig. 2, *E.* Peraeopod 4, second joint broadly expanded, with hind margin produced below into a broad rounding lobe. Peraeopod 5 somewhat as figured by Chevreux and Fage (Fig. 86, pr. 7) for *pelagica,* second joint broadly ex-

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[1] Received June 6, 1949.

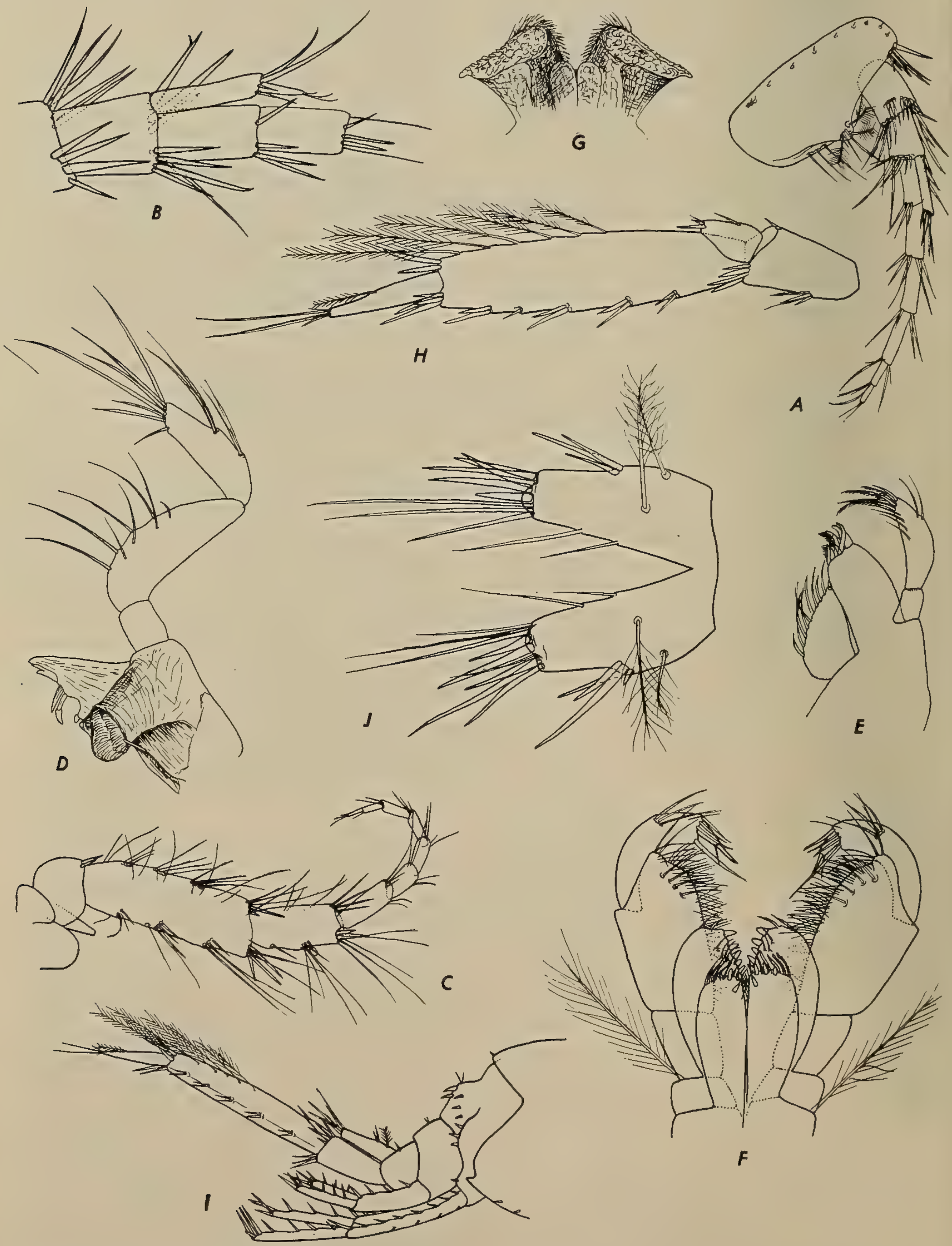

FIG. 1.—*Bathyporeia quoddyensis*, n.sp. Female: *A*, Antenna 1; *B*, antenna 1 enlarged showing the accessory flagellum; *C*, antenna 2; *D*, mandible; *E*, maxilla 1; *F*, maxillipeds; *G*, lower lip; *H*, uropod 3; *I*, hind end of animal; *J*, telson.

panded with the lower hind margin deeply excavate, whereas their figure shows only a small rather shallow excavation.

Uropods 1 and 2 rather long and slender, with spines as shown by Fig. 1, *I*. Uropod 3, outer ramus bearing groups of spines on outer margin and six plumose setae on distal half of inner margin of first joint; second joint with a single plumose seta on inner margin and a group of apical setae; inner ramus with a spinule on inner margin and two or three apically. Telson rather broad, cleft nearly to base, each lobe armed distally with a rather dense group of spines of varying length and thickness, lateral margins with a group of spines at the center, and inner margins bearing a few long slender spines. Each lobe bears on its upper surface a long plumose seta a little proximally of the center and a shorter plumose seta nearer the base.

The third metasome segment produced at the lower posterior corner into a rather prominent tooth above which the margin is markedly convex. The first urosome segment bears the usual dorsal depression and hump; the hump with two setae, posterior to which is a pair of stout backward-curving spines, and posterior to these still another pair of smaller spines. On the lateral side of this segment below the dorsal spines are three backward-curving spines. This segment curves upward from the first uropod forming a very low, flat, convex ridge bearing three spines. Length of female from front of head to end of third uropod from 4.5 to 5 mm.

Type.—A female taken inside West Quoddy Head, Maine, August 13, 1912, surface to 10 fathoms, fine sand, Biol. Board Canada no. 00410.

Besides the type, specimens were taken as follows: 1 specimen taken at Duck Pond, Campobello Island, August 13, 1912, 1–5 fathoms, sand, Biol. Board Canada no. 00408; 1 specimen in Bass River, Coblequid Bay, Minas Basin, September 12, 1921, surface; 1 specimen at Prince Station, no. 17, ¼ mile outside Bunker Island red light, Yarmouth Harbor, Nova Scotia, in 7 fathoms; and 2 specimens inside West Quoddy Head, Maine, August 13, 1912, 5–10 fathoms, Biol. Board Canada no. 00351.

Remarks.—The combination of characters that appears to distinguish this species is as follows: The protuberance on the under surface of the first peduncular joint of the first antenna; the considerable length of the fourth joint of the second antenna; the distally expanded first coxal plate; seventh joint of first gnathopod with the seta on the outer margin proximally placed, and the spinule on the inner margin distally placed; last peraeopod with the second joint greatly expanded and the posterior margin considerably excavated below; first urosome segment with both dorsal and lateral spines; telson with spines on the inner margins of the lobes, and the dorsal plumose setae placed proximally to groups of lateral spines.

The present records are the first for the occurrence of the genus *Bathyporeia* in America.

STENOTHOIDAE

Metopella angusta, n. sp.

Fig. 3

Description of female.—Head with lateral lobes acute. Eyes small, round, and yellowish brown in alcohol. Antenna 1 slightly shorter than 2; peduncular joints decreasing consecutively in length and thickness; flagellum shorter than peduncle and composed of about seven joints. Antenna 2, fourth and fifth joints about equal in length; flagellum shorter than peduncle and composed of about seven joints. Mandible, cutting edge toothed, accessory plate finely toothed; spine row with five or six spines; palp very short, 3-jointed, third joint very short. Maxilla 1, inner plate bearing one distal spinule; outer plate armed with six spine teeth; palp 1-jointed and armed distally with teeth and setae. Maxilla 2, inner plate short and bearing five spines; outer plate with nine spines. Maxillipeds, inner plates rather prominent and united for nearly their entire length; outer plates very short and bearing five spines on inner margin; third joint of palp longest.

Side plate 2 twice as deep as wide, front margin very convex, hind margin nearly straight and bearing several short spines. Side plate 3 more than twice as deep as wide with sides slightly converging distally and hind margin bearing about eight short spines. Side plate 4 very nearly as deep as wide with front margin nearly straight. Gnathopod 1 simple, sixth joint very slightly longer than fifth and bearing about six slender spines on hind margin, which is very finely serrulate. Gnathopod 2 much stouter than 1; second joint longer than fifth and sixth combined; sixth joint with very oblique straight palm, which is very finely serrulate throughout, defined by a short slender tooth and two stout spines.

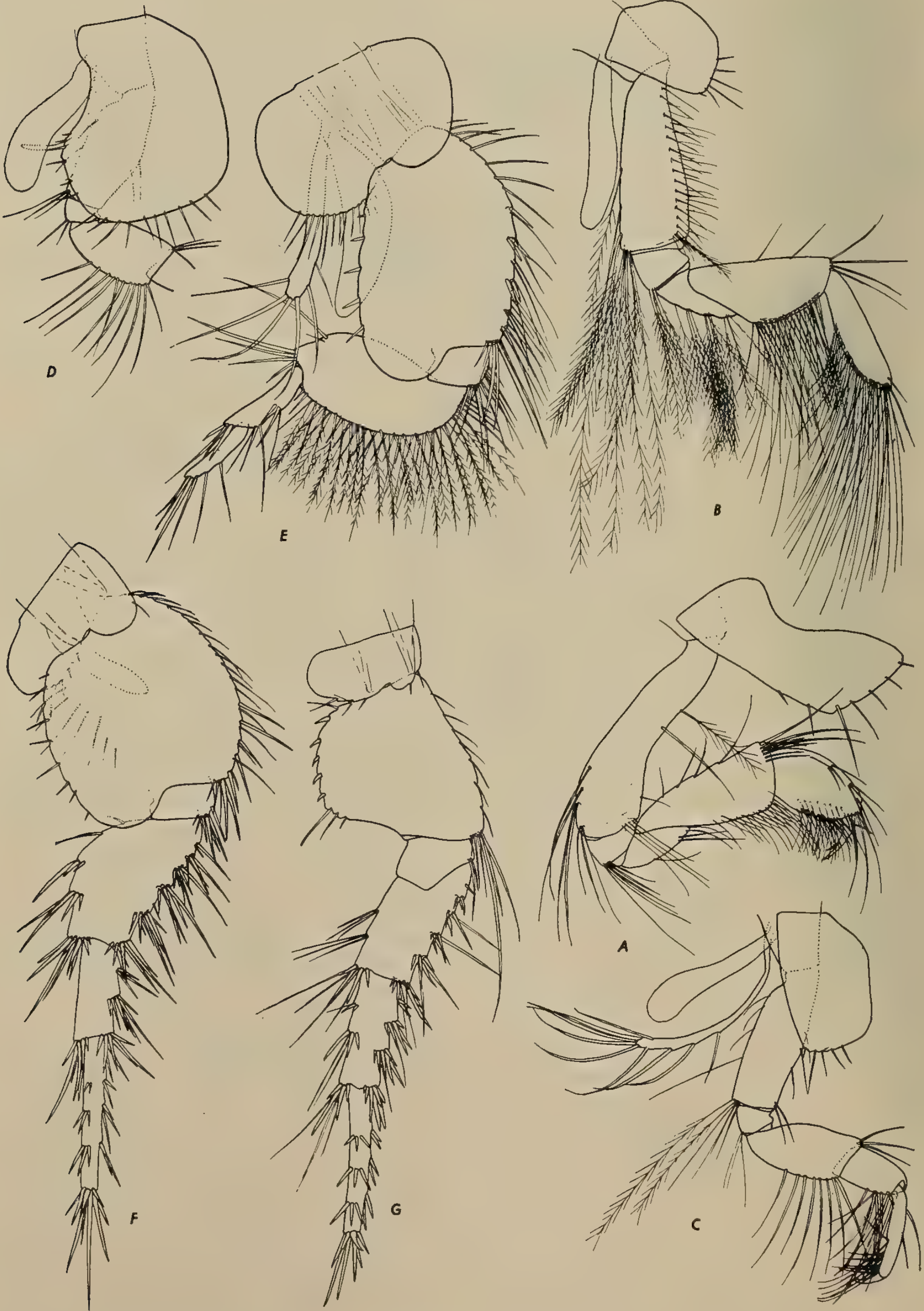

FIG. 2.—*Bathyporeia quoddyensis*, n.sp. Female: *A*, Gnathopod 1; *B*, gnathopod 2; *C*, peraeopod 1; *D*, peraeopod 2; *E*, peraeopod 3; *F*, peraeopod 4; *G*, peraeopod 5.

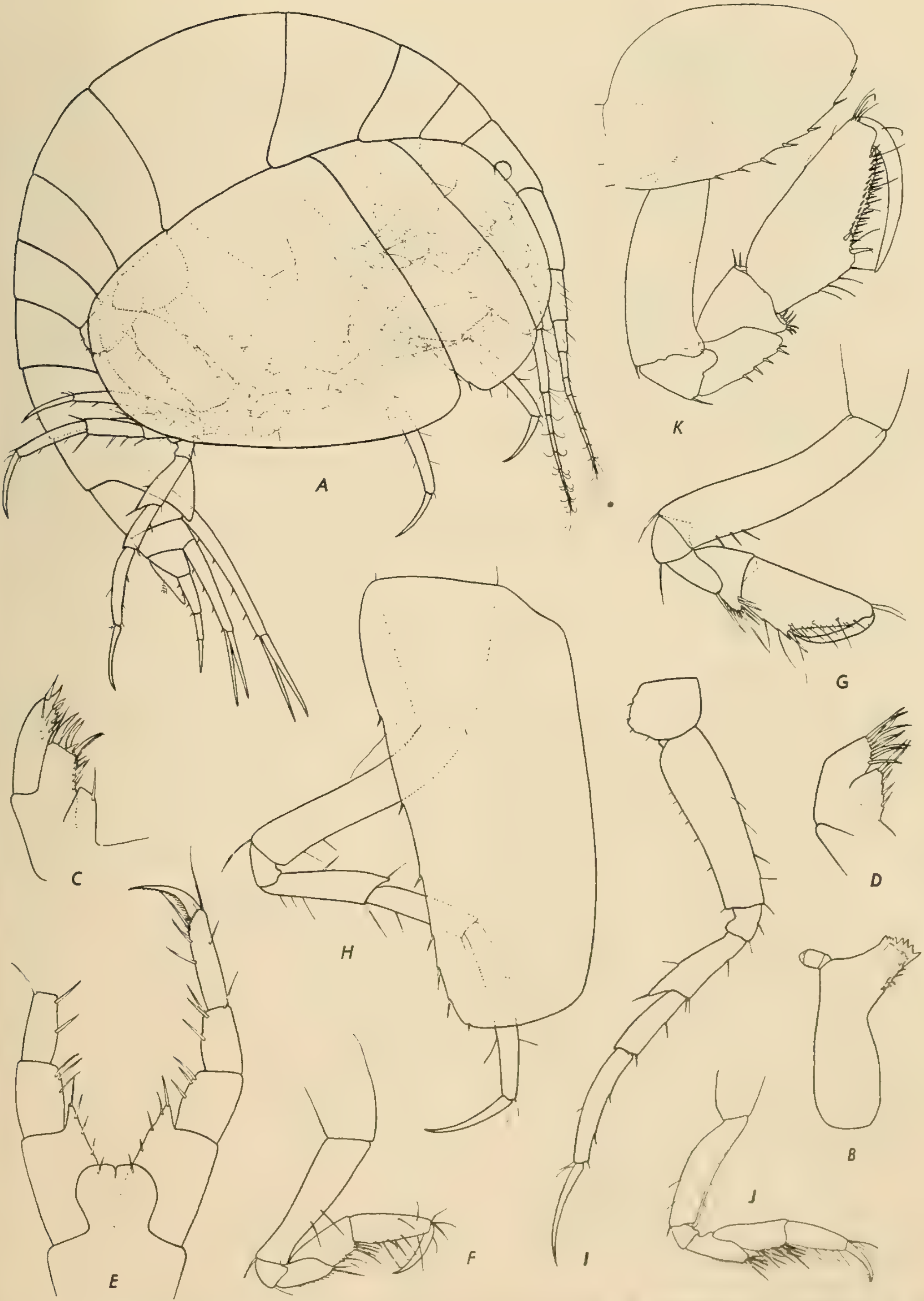

Fig. 3.—*Metopella angusta*, n.sp. Female: *A*, Entire animal; *B*, mandible; *C*, maxilla 1; *D*, maxilla 2; *E*, maxillipeds; *F*, gnathopod 1; *G*, gnathopod 2; *H*, peraeopod 1; *I*, peraeopod 5. Male: *J*, Gnathopod 1; *K*, gnathopod 2.

Peraeopods 1 and 2 subequal in length and thickness; fourth joint slightly expanded distally; sixth joint nearly as long as second; seventh joint in peraeopod 1 half as long as sixth joint, but in peraeopod 2 over half the length of the sixth joint. Peraeopods 4 and 5, second joint not expanded; peraeopod 4 shorter than 5, which in turn is shorter than 3; seventh joint of peraeopods 3 to 5 nearly as long as their respective sixth joint.

Uropods 1 to 3 decreasing consecutively in length, the upper edges of all the rami very finely serrulate. Telson without spines but bearing a plumose setule about the center of either lateral margin. Length of female about 3 mm.

Type.—A female from Duck Pond, Campobello Island, Bay of Fundy, August 13, 1912, 10 feet of water, fine clear sand, Biol. Board Canada no. 00516.

Description of male.—Antennae longer than in the female. Antenna 1, first and second peduncular joints long and slender and subequal in length; third joint about one-third the length of second; flagellum short and composed of about seven joints. Antenna 2, noticeably longer than 1; third, fourth, and fifth peduncular joints long and slender; fourth longer than fifth which in turn is longer than third; flagellum short, about as long as the fourth joint and composed of about seven joints. Gnathopod 1 much like that of female except that the fourth joint is produced forward partly under the fifth. Gnathopod 2 larger and stouter, and its side plate proportionately wider than in the female. The second joint of gnathopod 2 is produced distally into a short anterior lobe; the third joint also is produced into a short distal lobe; the fifth joint is produced below into a narrow, spinose lobe between the fourth and sixth joints; sixth joint twice as long as fifth, palm very oblique, about one-half the length of the joint, slightly convex, finely crenulate, and defined by a rounding protuberance bearing a stout spine. The palm is armed on the outside with short straight spines and on the inside with very short forward-pointing spines. In some specimens the palm bears at its center a tooth which is noticeably larger than the crenulations. The seventh joint is longer than the palm and reaches to the defining protuberance. In other characters the male agrees quite closely with the female. Length of male 3.5 to 4 mm.

Beside the type locality, Campobello Island, this species has been taken in the St. Croix River opposite Robinson, New Brunswick, August 10, 1912, Biol. Board Canada no. 00508; and at Niger Reef, St. Andrews, New Brunswick, August 6, 1912, Biol. Board Canada no. 00478.

In the collection of the United States National Museum there are specimens of this species from *Fish Hawk* station 918, July 16, 1881 (lat. 40° 20′ 24″ N., long. 70° 41′ 30″ W.) off Marthas Vineyard in 44 fathoms; *Albatross* station 2261, lat. 40° 04′ 00″ N., long. 69° 29′ 30″ W., September 28, 1884, 58 fathoms; *Albatross* station 2497, lat. 45° 04′ 00″ N., long. 59° 36′ 45″ W., July 6, 1885, 57 fathoms. A specimen was taken by the *Albatross* in the Atlantic off Nova Scotia in 1885.

PLEUSTIDAE

Stenopleustes gracilis (Holmes)

Fig. 4

1903. *Apherusa gracilis* Holmes, Amer. Nat. **37:** 287.

1905. *Apherusa gracilis* Holmes, Bull. Bur. Fish. **24:** 495, fig.

1905. *Apherusa gracilis* Rathbun, *Fauna of New England*, 5, Orig. Pap. Boston Soc. Nat. Hist. **7:** 65.

S. J. Holmes (1905, p. 495) when describing this species placed it in the genus *Apherusa*. An examination of the mouth parts, however, appears to indicate that they conform much more closely to those of the genus *Stenopleustes*. As other external characters also agree quite closely with those of *Stenopleustes*, I am here transferring the species to that genus. I am redescribing and figuring the species in order to make it more easily recognizable. The sexes are so much alike that separate descriptions are unnecessary.

Description.—Head with rostrum broadly triangular and curving downward; lateral corners rounding, and lower angle not at all produced. Eye reddish brown in alcohol and longer than deep. Antenna 1 twice as long as 2; flagellum composed of many joints. Antenna 2, fourth joint of peduncle longer than fifth. Mandible with three spines in spine row; molar cylindrical and strong; third joint of palp longer than second. Maxilla 1, inner plate broadly truncate and bearing a single plumose seta; outer plate with six finely serrate spine-teeth; palp with five or six terminal spine teeth and three or four subterminal setules. Maxilla 2 normal, but without any prominent setae on inner margin of inner plate. Maxillipeds, inner plate rather short and broad with two terminal spinules and two low blunt teeth; outer plate without marginal spine teeth, but bearing a

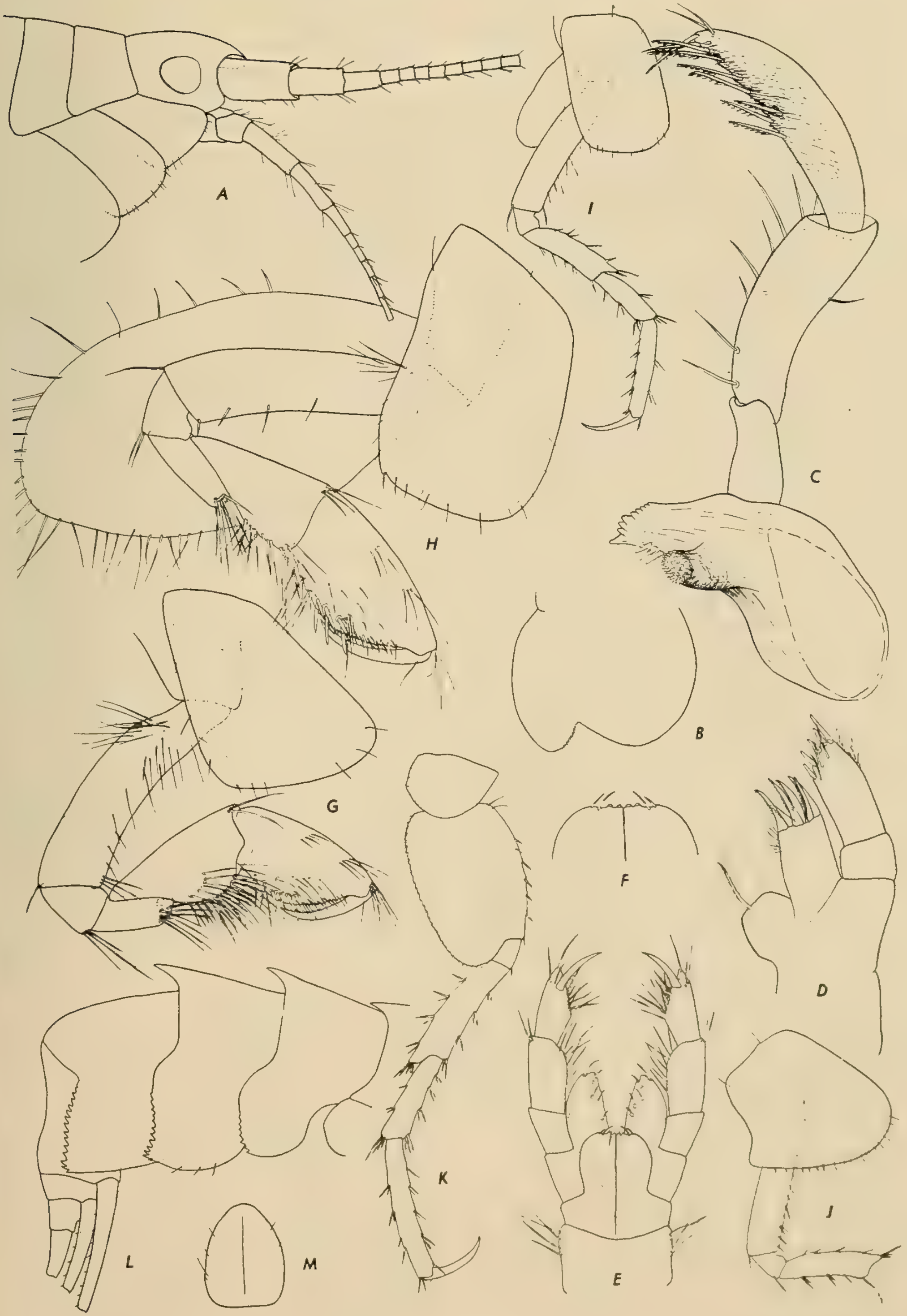

Fig. 4.—*Stenopleustes gracilis* (Holmes). Female: *A*, Front end of animal; *B*, upper lip; *C*, mandible; *D*, maxilla 1; *E*, maxillipeds; *F*, distal ends of the inner plates of maxillipeds; *G*, gnathopod 1; *H*, gnathopod 2; *I*, peraeopod 1; *J*, peraeopod 2; *K*, peraeopod 5; *L*, hind end of animal; *M*, telson.

few submarginal spinules and one terminal spine; palp slender, third joint apically produced. Upper lip unsymmetrically bilobed, the smaller lobe with very fine teeth on inner margin. Lower lip normal and much as figured by Sars for *Stenopleustes malmgreni* (*Crustacea of Norway* **1:** pl. 125, 1, 2).

Gnathopods 1 and 2 very much alike, but 2 somewhat the larger. Gnathopod 1, second joint nearly as long as the fifth and sixth combined; fifth joint as long and as wide as sixth, with lower margin broadly convex and spinose; sixth joint, palm evenly convex, finely serrate, and defined by several long spines; seventh joint fitting palm. Gnathopod 2, fifth joint shorter and narrower than sixth; sixth joint like that of gnathopod 1, but proportionally a little longer and narrower; seventh joint fitting palm. Peraeopods 1 and 2 slender and much alike, seventh joint rather long and slender. Peraeopods 3 to 5 with second joint expanded, succeeding joints slender.

Mesosome segment 7 and metasome segments 1 and 2 produced backward dorsally into a sharp tooth. Metasome segments 1 to 3 with lower posterolateral margin serrate. Uropod 1, inner ramus about as long as peduncle and a little longer than outer ramus. Uropod 2, inner ramus much longer than peduncle and nearly twice as long as outer ramus. Uropods 1 and 2 reaching back about the same distance. Uropod 3 not reaching back as far as 2, inner ramus about one-third longer than outer ramus. Peduncles of uropods 1 and 2 and rami of all uropods armed with very short spines. Telson a little longer than wide, deeply keeled and not reaching to end of peduncle of uropod 3. Length from front of head to end of uropods about 6 mm.

Holmes described this species from two rather imperfect specimens taken off Gay Head, Marthas Vineyard; and in his *Synopsis of North American invertebrates, XVIII: The Amphipoda* (Amer. Nat. **37:** 287) he gives Cape Cod to Cape Hatteras as the range. In the collection of the U. S. National Museum I have not been able to find any specimens taken farther south than *Albatross* station 2261, lat. 40° 04′ N., long. 69° 29′ W. (off New Jersey). The species was taken at a number of stations in the Bay of Fundy by the Biological Board of Canada from 1912 to 1916.

Stenopleustes gracilis inermis, n. var.

This variety is like the typical form except that it is somewhat smaller and lacks the dorsal teeth on the seventh segment of the mesosome and the first and second segments of the metasome.

The type, a female, taken at Wolves Islands, Passamaquoddy Bay, August 17, 1912, 20 to 30 fathoms, sand, mud, and shells, Biol. Board Canada no. 00444.

Other specimens were taken in the lower part of the St. Croix River and Passamaquoddy Bay in 1912 and 1913.

Remarks.—T. R. Stebbing in *Das Tierreich*, p. 309, characterizes the genus *Stenopleustes* as having only one seta on the inner plate of maxilla 1. *Stenopleustes eldingi* Gurjanova, however, has three setae on this plate, and so it seems the definition should be altered to one to three setae on inner plate of maxilla 1.

COROPHIIDAE

Unciola obliquua, n. sp.

Fig. 5

Male.—Head, rostrum triangular, lateral lobes not very large and distally rounding. Eyes on lateral lobes, but very indistinct as specimens had been in preservative a long while. Antenna 1 longer than 2; first joint of peduncle quite stout and nearly as long as second and third joints combined; second joint not quite twice as long as third; flagellum shorter than peduncle and composed of nine joints; accessory flagellum 1-jointed and reaching to about the middle of the first joint of the primary flagellum. Antenna 2, gland cone prominent; third joint rather stout and a little longer than the fourth joint; fourth joint stouter and longer than fifth joint; flagellum a little longer than the fifth peduncular joint and composed of five joints.

Mouth parts normal for the genus *Unciola*. Maxilla 1, inner plate small and bearing two setae on the broadly rounding upper edge; outer plate with nine spine teeth; palp with second joint long. Mandible with third joint of palp shorter than the second. Coxal plates 1–4 shallow, not contiguous and produced forward, the first narrowly and acutely so, 2–4 less produced consecutively. Fifth, sixth, and seventh coxal plates with the front lobe produced triangularly downward. Gnathopod 1, second joint short, stout, and very strong; fifth joint shorter but as wide as sixth; sixth joint widest distally, palm not very oblique, about as long as hind margin of joint, bearing a slight prominence about the center and defined by a lobe bearing a stout spine which is preceded by a smaller spine; seventh joint stout and not overlapping palm. Gnathopod 2 slender; fifth joint longer than sixth; sixth joint narrowing distally; palm transverse, very short and defined by a slight lobe bearing a small apical spine; fifth and sixth joints provided with dense groups of long bristles.

Peraeopods 1 and 2 much alike and subequal in length; second, fourth, and fifth joints expanded and these together with the sixth joint bearing long slender spines on their hind margin; seventh joint with two spinules on inner margin. Peraeopod 3, second, fourth, and fifth joints expanded and fourth joint bearing many long slender plumose setae on the front and hind margin; fifth joint with two spines on hind margin; seventh joint with two spinules on inner margin. Peraeopod 4 much like peraeopod 3 but longer; second, fourth, and fifth joints expanded; seventh joint with spinules on inner margin. Peraeopod 5, longer than 4; second joint expanded; fourth joint somewhat expanded; seventh joint nearly as long as sixth and bearing four spinules on inner margin.

Metasome segments 1 and 2 with lower hind corner narrowly and acutely produced backward; segment 3 with lower margin continued obliquely upward and backward to the point of attachment to the first urosome segment, thus lacking the acutely produced lower corner which is usual in the genus *Unciola*. Urosome segment 3 is so short that it is not discernible except ventrally at the attachment of the third uropods. Uropod 1, outer ramus a little over half the length of the peduncle, armed apically with the usual stout spines, and on the outer margin with three long slender spines; inner ramus reduced to a little over half the length of the outer ramus and bearing a single small apical spinule; peduncle rather flat and

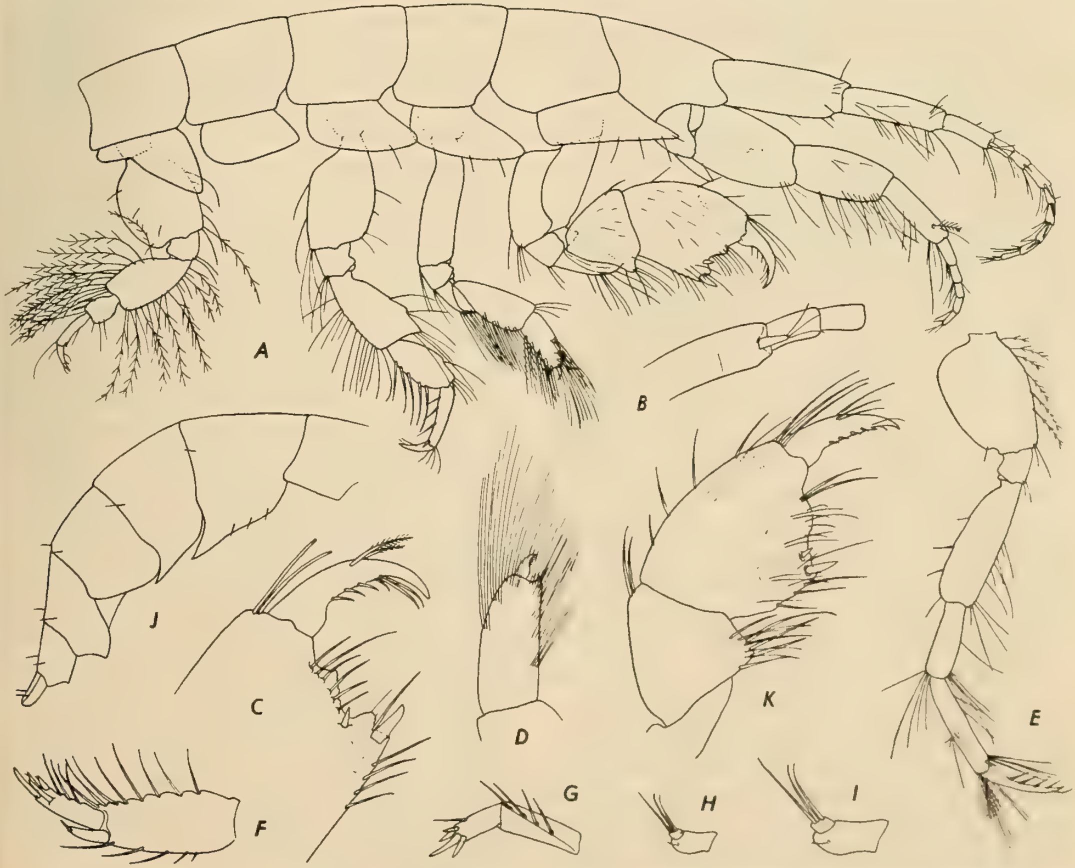

Fig. 5.—*Unciola obliquua*, n.sp. Male: *A*, Front end of animal; *B*, antenna 1 enlarged showing the accessory flagellum; *C*, gnathopod 1; *D*, gnathopod 2; *E*, peraeopod 5; *F*, left uropod 1; *G*, left uropod 2; *H*, left uropod 3; *I*, left uropod 3 enlarged; *J*, hind end of animal. Female: *K*, Gnathopod 1.

broad and bearing a row of long slender spines on outer and inner margin. Uropod 2 bears only the outer ramus which is nearly as long as the peduncle; peduncle with a row of long slender spines on outer margin. Uropod 3 very short, extending very little beyond the telson, and bearing only a vestigial outer ramus armed with three long apical spinules. Telson broader than long, somewhat truncate distally and bearing a seta on either lateral margin. Length of male from front of head to end of uropods 5 mm.

Female.—The female is like the male except that the antennae and first gnathopod are not quite so strong. Gnathopod 1 is much like that of the male, but the palm is more oblique, less sinuous and is not defined by a lobe. Length of female from front of head to end of uropods about 4 mm.

Type.—A male selected from several found in the stomachs of haddocks, nos. 58 and 62, taken by A. W. Needler in the Bay of Fundy.

Five females were taken by the steamer *Speedwell* (no. 141) in Gloucester Harbor, Mass., August 1, 1878, in 8.5 fathoms, and one male was taken by the *Speedwell*, no. 321, lat. 42° 03′ N., long. 70° 15′ W., in Cape Cod Bay, Mass., August 30, 1879, in 29.5 fathoms.

ZOOLOGY.—*Four new species of the acanthocephalan family Neoechinorhynchidae from fresh-water fishes of North America, one representing a new genus.*[1] HARLEY J. VAN CLEAVE, University of Illinois, and RALPH V. BANGHAM, College of Wooster. (Communicated by WALDO L. SCHMITT.)

In previous publications (Van Cleave, 1945, 1947, and in press; and Van Cleave and Manter, 1948) it has been demonstrated that speciation in the Acanthocephala has been significantly associated with speciation of fish hosts, particularly in North America. This parallel in evolutionary progress of parasites and their hosts has been especially conspicuous in the family Neoechinorhynchidae (class Eoacanthocephala, order Neoacanthocephala). In this family diversification of its members has attained two entirely different levels. At the lower of these, by purely quantitative changes in the pattern of structure, distinctive species have evolved, while at the higher level differentiation of the parasites has gone so far that completely new qualitative features have become established. As a consequence, these forms are no longer recognizable as belonging to the original parent genus, since they have attained new structural expressions in features which taxonomists recognize as capable of reflecting generic differences. At the level of specific differentiation, the genus *Neoechinorhynchus* has undergone explosive speciation in the North American fauna so that at the present time ten species of this genus are known in the literature for this continent and three more are to be added in the present contribution.

At the generic level the differentiation of the Neoechinorhynchidae along with the evolution of the American fish fauna has resulted in the establishment of five distinctive genera previously recognized in the literature. These are *Octospinifer* in Catostomidae, *Eocollis* in Centrarchidae, *Atactorhynchus* in *Cyprinodon*, and *Gracilisentis* and *Tanaorhamphus* in *Dorosoma*. To these is herein added the sixth distinctively North American genus of the Neoechinorhynchidae —*Paulisentis*, which occurs in the creek chub, *Semotilus atromaculatus atromaculatus* (Mitchill). *Paulisentis fractus*, genotype of the newly recognized genus, has been found in a very localized portion of the broad geographical range of the host species, in Wayne County, in the north-central part of Ohio.

At the specific level of differentiation, the three new species of the genus *Neoechinornorhynchus* named and described in this paper include an additional distinctive species, *N. saginatus*, characteristic of the creek chub in Wisconsin; *N. tumidus*, apparently restricted to ciscoes and whitefishes of the Northern States and Canada as definitive hosts; and *N. doryphorus*, a peculiarly modified member of the genus as yet known from a single species of definitive host from Florida.

With the exception of some of the material of *N. saginatus* collected by J. Fischthal and some of the specimens of *N. tumidus*

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[1] Received July 7, 1949.

taken by other collectors, all the specimens that serve as basis for the new species here described have been collected by Bangham in the course of parasite surveys in Ohio, Florida, and Wisconsin.

It is rather remarkable that within a single host species, the creek chub, both the generic and the specific levels of differentiation of its parasites in the Neoechinorhynchidae have been attained. Each of these species seems to be rather definitely limited in its geographical distribution, and although extensive field studies have been made there is as yet no evidence that the two species ever occur in the same locality. The only other instance of a distinctive North American fish with two distinctive species of Neochinorhynchidae is that of *Dorosoma cepedianum* (LeSueur) with its *Gracilisentis gracilisentis* (Van Cleave) and *Tanaorhamphus longirostris* (Van Cleave). Not only do these occur in the same locality, but it has been shown (Van Cleave, 1916, p. 109) that each occupies a seasonal ecological niche within the intestine of *Dorosoma*. At present there are no facts available to explain why the two species of Neoechinorhynchidae adapted to the creek chub have failed to extend their respective geographical distributions beyond their present limits.

Paulisentis fractus has been found in the creek chub in Ohio but never in any other part of the range of the chub, while *Neoechinorhynchus saginatus* occurs in the same host only in Wisconsin. Extensive field surveys in both Wisconsin and Ohio have failed to give evidence that either species of the chub parasites occurs in other vertebrate hosts that might be the normal hosts with the chub, in either instance serving as accidental host of a species normally adapted to a different host species.

The hypothesis that evolutionary changes in the host are accompanied by correlated evolutionary changes in the parasite here appears to lack the obvious support which it receives in some other instances. It seems self-evident that the two different acanthocephalan species of the creek chub probably originated from different ancestral stocks rather than from a common species which was resident in the intestine of the ancestors of the present day chub throughout its geographical range. Available facts give no conclusive evidence as to the lines of descent of the present day parasites of the chub.

It is very unusual for two such diverse species of Acanthocephala to be established in a single host species in a condition of apparently rather strict host specificity while each occupies but a very restricted portion of the geographical range of that host. One of the most obvious explanations might be that each species of the parasite has as an essential intermediate host some species of arthropod whose geographical distribution is distinctly limited. Yet another possible explanation is that in the case of either or both of the species of parasites the chub may be an incidental or accidental definitive host, while some other species of vertebrate, as yet undiscovered, may be the normal host for the parasite.

Within a single host species clearly different levels of diversification of its acanthocephalan parasites may occur. This observation leads to the conclusion that the extent of modification of the fish host does not find direct, quantitative expression in the extent of the modifications of its parasites.

An appreciation of the wide dispersal of *Semotilus atromaculatus atromaculatus* is gained in the following quotation from Hubbs and Lagler (1941, p. 53): "From Montana and from the Red River of the North drainage to the Gaspé Peninsula in Canada, southward on both sides of the Appalachians to Georgia and other Gulf States, southwesterly to the Ozark Upland and the Arkansas and upper Pesos river systems in New Mexico." Over such a broad expanse of territory the fish encounters highly diversified physical and biological environments which seem to have had no direct effect upon producing variability in the fish. In many parts of its geographical range the creek chub is apparently entirely free from acanthocephalan parasites.

In North America, speciation within the genus *Neoechinorhynchus* has been extremely active and the genus has become highly diversified (Van Cleave, in press) to the extent that many fish hosts have their own distinctive species, although the adaptations between parasite and host often permit of more than a single host species. Similarity in food habits often seems to be more important in expanding host relations than mere blood relationship of the vertebrate hosts although conditions become pyramided in the expansion of host relations when closely related species of fish have identical food habits. Specific adaptations between some members of the genus *Neoechinorhynchus* and peculiar North American fishes and wide host tolerance of others combine to produce contradictory impressions which introduce many difficulties into the recognition of the species of *Neoechinorhynchus* encountered in surveys of fish parasites. The genus is so distinctive that recogtion at the generic level is easily assured on features of general morphology. However, specific identification is often impossible in field studies and must await detailed measurements and comparisons even when intangible evidences seem to set specimens apart as different from all the species previously recognized.

The authors of the present paper have, on numerous occasions, encountered specimens of Neoechinorhynchidae that could not be identified at once. In preliminary reports, these have often been referred to as *Neoechinorhynchus* sp. (Bangham, 1940, p. 299; 1941, p. 163, 164; 1946, p. 321). Several of these undetermined species have been studied critically along with other unidentified specimens from Canada and from the Eastern United States, and in many instances further field studies have been made specifically to secure additional specimens of the critical material for study. In addition to the distinctive *Paulisentis fractus*, three additional species of *Neoechinorhynchus* are being described in this paper. Several other species remain unnamed and undescribed in the authors' collections, pending the discovery of better or more adequate material to justify their diagnosis.

Paulisentis, n. gen.

Diagnosis.—With the characters of the family Neoechinorhynchidae. Proboscis small, shortly cylindrical, provided with relatively weak hooks arranged, not in perfect circles and longitudinal rows but as six diagonal rows of five hooks each. Body wall relatively thick. Musculature of male bursa poorly developed. Parasitic in the intestine of fresh-water fishes. Development unknown.

Type species: *Paulisentis fractus*, n.sp.

Paulisentis fractus, n. sp.

Figs. 1–5

Description.—With the characters of the genus *Paulisentis*. Body short, very broad, without marked attenuation at either extremity, terminating bluntly (Figs. 1, 2). Females (Fig. 1) 2.3 to 4 mm long, with maximum width of about 0.6 to 0.8 mm. Body wall often 0.079 to 0.132 mm in thickness. Proboscis (Figs. 4, 5) 0.093 to 0.105 mm in width and 0.089 to 0.120 mm in length. Males (Fig. 3) 1.4 to 2.86 mm long by 0.410 to 0.620 mm wide. Proboscis but very slightly smaller than in female.

Proboscis hooks (Figs. 4, 5) minute, not conspicuously different in the two sexes; not in perfect transverse and longitudinal rows but in approximately six diagonally spiral lines of five hooks each, making a total of about 30 hooks on the entire proboscis instead of the 18 distinctive of the genus *Neoechinorhynchus*. Hooks near tip of proboscis 24 to 27μ long; in middle region 19 to 27μ; at base 11 to 16μ; the largest hooks from 4 to 6μ in diameter at the bend where thorn and root join. Root processes never conspicuous, poorly defined.

In some males the genital organs (Fig. 3) extend practically the entire length of the trunk; the two testes in broad mutual contact and cement gland (C) broadly joined to the hind testis (T). Anterior testis often touching the posterior end of the proboscis receptacle. Cement gland somewhat shorter than either testis.

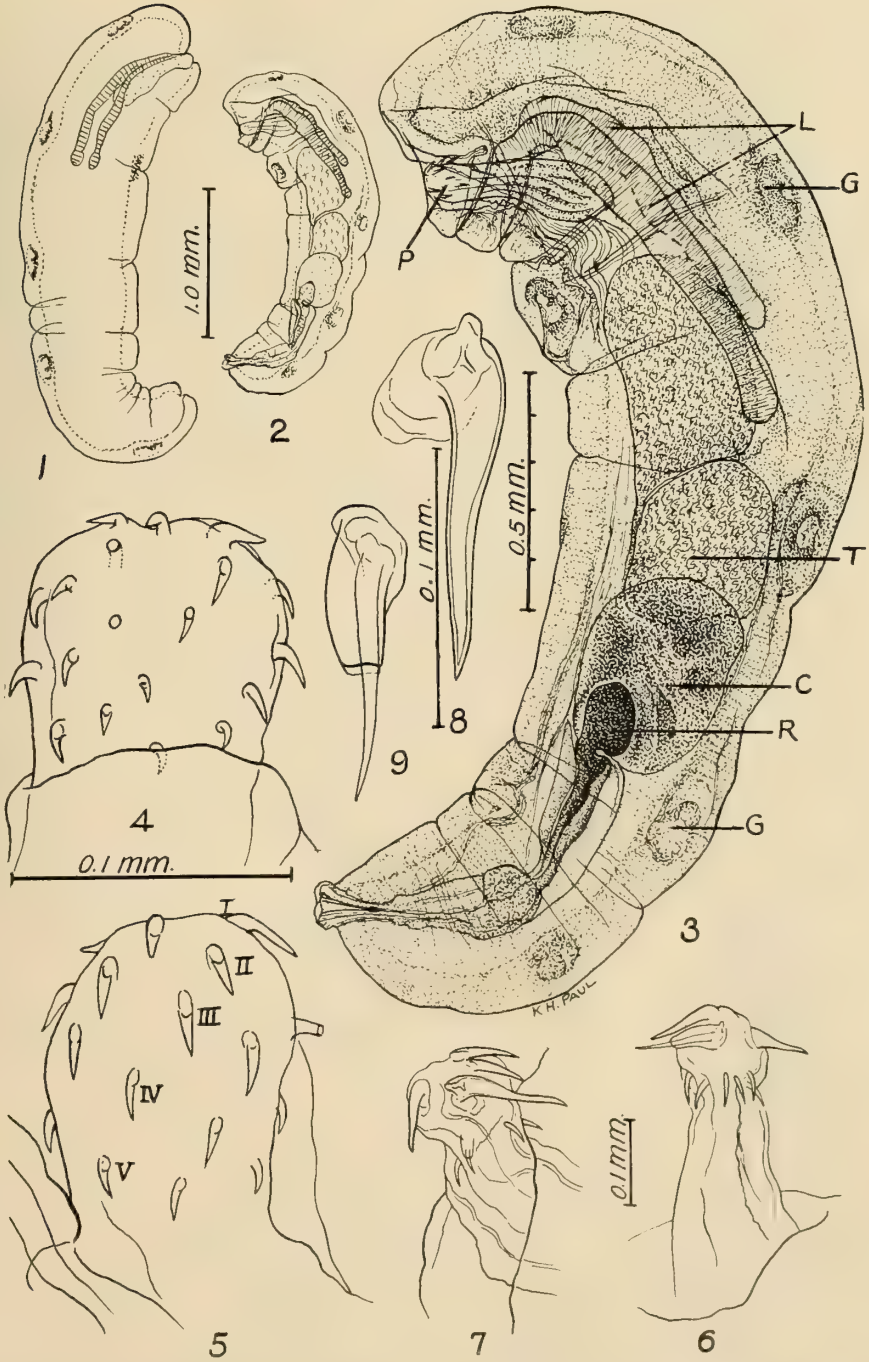
Lemnisci (L), when fully extended, usually reaching to the interval between the second and third dorsal subcuticular giant nuclei. Nuclei of the lemnisci not distinguishable in available material.

Shelled embryos within body cavity of gravid female 35 to 38μ long by 11 to 14μ wide. Development wholly unknown.

Definitive host.—*Semotilus atromaculatus atromaculatus* (Mitchill), the creek chub from streams in Wayne County, Ohio, collected by R. V. Bangham.

Type material.—Holotype male, U.S.N.M. Helm. Coll. no. 37128. Allotype female (VC 3713.1) and series of paratypes representing both sexes in the collection of H. J. Van Cleave, Urbana, Ill., and paratypes in the collection of R. V. Bangham, Wooster, Ohio.

In all the specimens available for this study, at least the base of the proboscis was retracted



FIGS. 1–5.—Morphological details of *Paulisentis fractus*, n.g. and sp.: 1, 2, Outline drawings showing characteristic body form of paratype female (1) and holotype male (2) and relative size and shape of the two sexes; 3, analytical study of morphology of holotype male; 4, 5, typical proboscides when dissected from their retracted position within front end of trunk.

FIGS. 6–9.—Morphological details of *Neoechinorhynchus doryphorus*, n.sp.: 6, 7, Proboscis and its attachment to trunk, viewed from opposite lateral surfaces to show disparities in lateral hooks of terminal series; 8, 9, detail showing form and structure of the two highly modified lateral hooks.

within the front end of the trunk (Fig. 3), and in many the entire proboscis was completely obscured by retraction. The delicate hooks could not be measured nor could their arrangement be determined with accuracy in retracted individuals. The writers are particularly indebted to Mrs. Jean A. Ross for skillfully dissecting out the minute proboscis from many of the worms and making stained permanent mounts of the dissected parts. Without these mounts the details of the proboscis and its hooks could not have been determined.

Since the genus *Paulisentis* is monotypic, the comparisons of *P. fractus* must be confined to species of other genera of the Neoechinorhynchidae. The presence of more than three circles of proboscis hooks very distinctively sets it apart from all species of the genera *Neoechinorhynchus*, *Octospinifer*, *Eocollis*, and *Gracilisentis*, which are all characterized by the rigorous imposition of a hook formula invariably involving three circular rows. The genera *Atactorhynchus* and *Tanaorhamphus* are the only North American members of the family having more than three circles of hooks. From *Atactorhynchus*, *P. fractus* is easily distinguishable through differences in form of the body, extent of the male genital organs and number and arrangement of the proboscis hooks. From the two described species of *Tanaorhamphus*, *P. fractus* differs in the shape and size of the proboscis and number of its hooks and shape of the body.

Neoechinorhynchus saginatus, n. sp.

Figs. 12–25

In the course of extensive surveys of parasites of fishes of Wisconsin, large numbers of an undetermined species of the genus *Neoechinorhynchus* were discovered in the intestine of the creek chub (*Semotilus atromaculatus atromaculatus*) by R. V. Bangham and by J. Fischthal. Materials from both of these studies have been available for study and on these collections is based the description of *Neoechinorhynchus saginatus*, n.sp., a form with very prominent sexual dimorphism. Measurements of the proboscis and its hooks, features which are so readily available for differentiating the various species of *Neoechinorhynchus*, seemed to justify the assumption that these specimens from the chub in Wisconsin might belong to *N. rutili* (Müller) a species which has recently been determined for the American fauna in a paper now in press (Van Cleave and Lynch). However, a glance at a series of the specimens gave absolute proof that in reducing the comparisons to a few selected features some differences of distinctive nature were being disregarded (cf. Figs. 10 and 11 with 12 and 13). General shape of the body, position of the proboscis in its relations to the trunk and size of the male reproductive organs in comparison with the body size are all features that add support to the distinctive body sizes of the two sexes in the material from the creek chub.

An extensive study of *N. rutili* has revealed (Van Cleave and Lynch, in press) that females of that species never exceed a length of 10 mm. This limit in size is likewise recorded for the European representatives of the same species by Meyer (1932; p. 172). Consequently, when females in chubs were found often between 15 and 20 mm in length, it seemed obvious that such discrepancy in size adds its support to the distinctive though minor morphological features and specific host relationship. Although the material from the chub was taken from the same regions where *N. rutili* was established in other hosts, the latter was never recognized in chubs nor was

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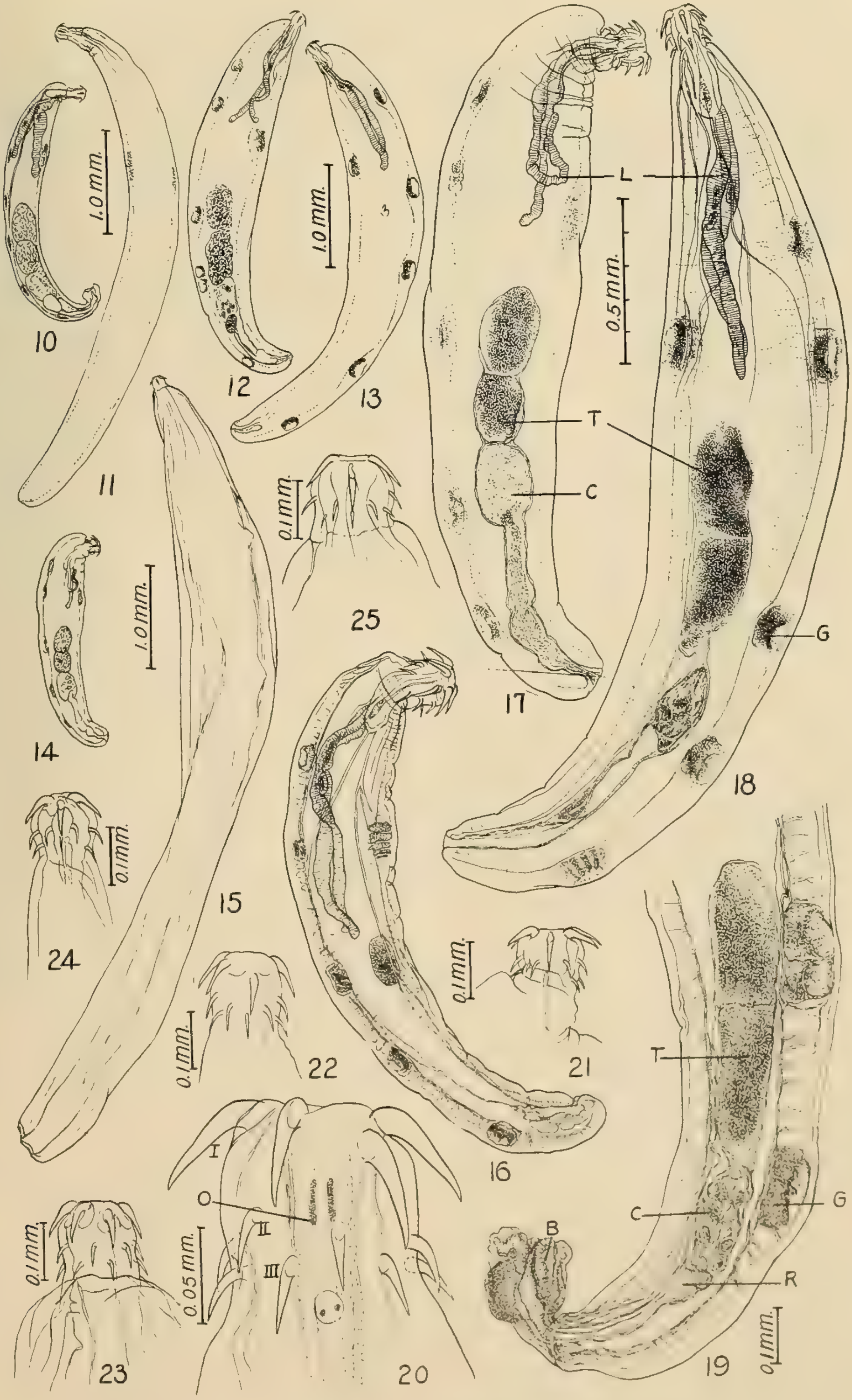
Figs. 10–25.—Morphological features of *Neoechinorhynchus saginatus*, n.sp., and comparison with general appearance of *N. rutili* (Müller): 10, 11, Male and female of *N. rutili* showing relative size of typical individuals of the two sexes and general proportions for body of each (note that female, Fig. 11, is of about maximum size for this species); 12, 13, male and female of *N. saginatus* showing distinctive difference of body shape from that of *N. rutili*, the female (Fig. 13) a very young immature individual; 14, 15, characteristic male and female of *N. saginatus* from intestine of same specimen of creek chub, showing prominent sexual dimorphism, especially in size, the female (Fig. 15) considerably below average maximum size for females of this species (a female of near maximum size from same host individual if drawn to same scale would be half again longer than entire length of this plate); 16, juvenile female of *N. saginatus* from intestine of a creek chub, before the egg balls have formed; 17, 18, typical males of *N. saginatus* showing topography of genital organs (in Fig. 18 the testes have already begun to break up); 19, posterior extremity of male of *N. saginatus* with copulatory bursa partially extruded; 20, proboscis of female of *N. saginatus* greatly enlarged to show characteristic arrangement of the two elongated and a single spherical nucleus in the distinctively elongated terminal organ of proboscis; 21–25, individual variation in size and appearance of proboscis of *N. saginatus*, all drawings to same scale.



Figs 10-25.—(See opposite page for explanation).

the new species, *N. saginatus*, ever found in other fishes.

Description.—With the characters of the genus *Neoechinorhynchus*. In fully grown individuals showing extreme sexual dimorphism in size (cf. Figs. 14 and 15). Body more nearly robust than cylindrical, with relatively thick body wall. Females often attaining a length of 20 mm, with a diameter of 1.25 to 2.1 mm in large, gravid females, in the vicinity of the second dorsal or the ventral giant subcuticular nucleus; posteriorly tapering gradually; anterior extremity somewhat enlarged, often with a slightly humpbacked appearance (Figs. 12, 17) in the region where the trunk reduces to join the neck and proboscis. Proboscis usually emerging from near the ventral margin of the anterior extremity of the trunk and rarely standing at a conspicuous angle to the body axis. Proboscis commonly 105 to 119μ long by 79 to 132μ wide. The hooks of the terminal circle usually 58 to 67μ long with a diameter of 16μ at the point where the thorn joins the root. Hooks of middle circle 31 to 38μ long; of basal circle 27 to 32μ long. Males diminutive when compared with fully grown females (cf. Figs. 14 and 15) commonly not more than 8 mm with a maximum diameter of from about 0.7 mm to 1.4 mm. Proboscis and its hooks not appreciably different from those of female. Male genital organs occupy only about the posterior half of the body cavity and are regularly of less diameter than the width of the body cavity. Hard shelled embryos within gravid females 44 to 46μ long by 16 to 20μ wide.

Type host.—*Semotilus atromaculatus atromaculatus* (Mitchill) in streams and lakes of Wisconsin.

Type material.—Holotype male (U.S.N.M. Helm. Coll. no. 37130) and allotype female (U.S.N.M. Helm. Coll. no. 37131). Paratypes in collection of H. J. Van Cleave, Urbana, Ill., and in collection of R. V. Bangham, Wooster, Ohio.

Remarks.—*N. saginatus* is morphologically nearest to *N. rutili*, from which it differs especially in proportions of the body. These differences are most readily appreciable through comparison of Figs. 10 and 11 with Figs. 12 to 14. The proboscis hooks of the terminal and middle series in *N. saginatus* tend to be smaller than those of *N. rutili* but there is so much variability in the latter that some individuals are found in which this difference is not a valid basis for separating the species. The embryos of *N. saginatus* are usually considerably longer (44 to 46μ) than those of *N. rutili* (30 to 40μ).

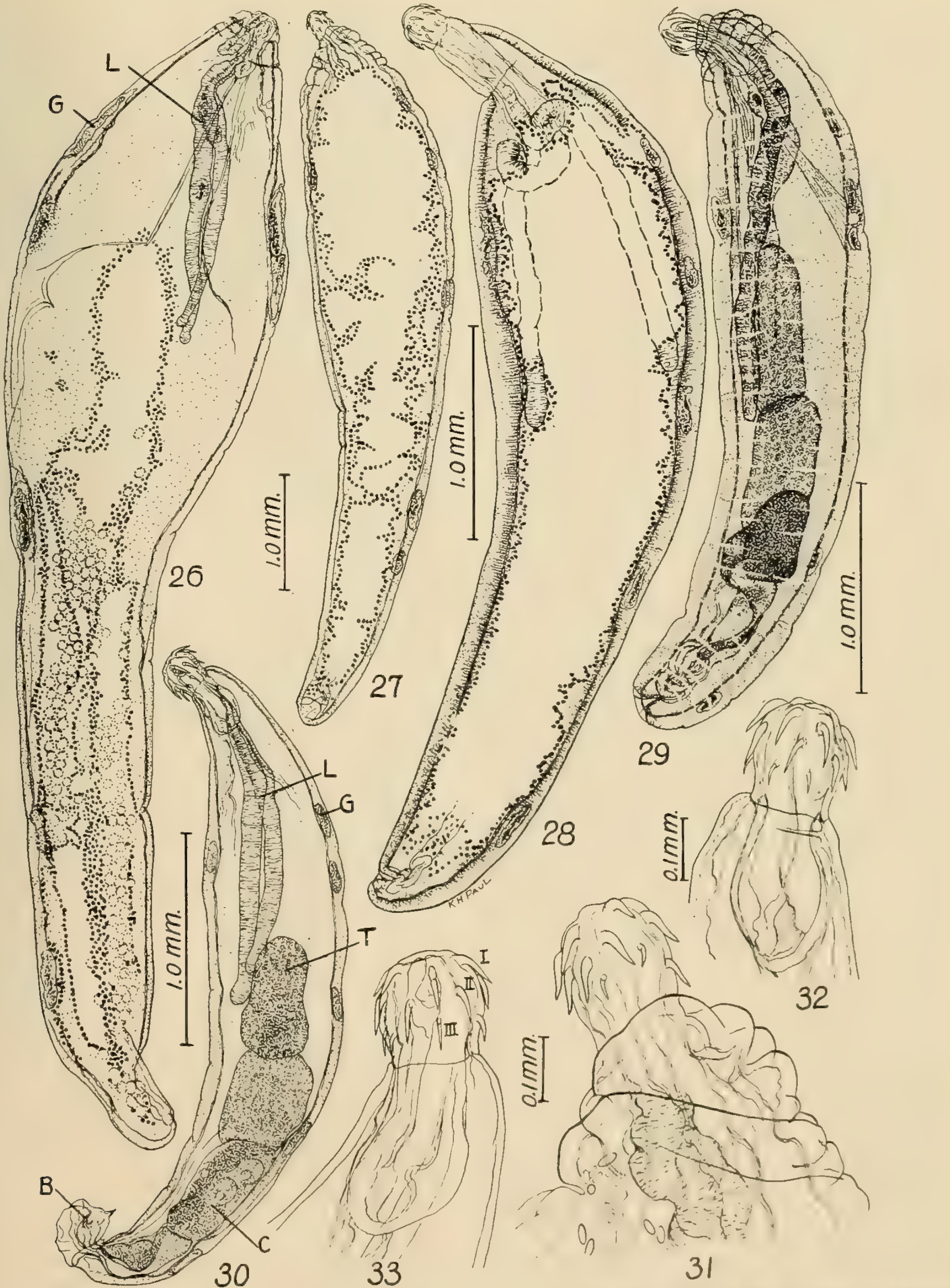
Neoechinorhynchus tumidus, n. sp.

Figs. 26–32

There have been but few instances of Acanthocephala reported from ciscoes and whitefishes of North America. Most of the recorded instances are of apparently accidental infection by species of Acanthocephala common in other fishes of the habitat under consideration. In America, *Echinorhynchus coregoni* Linkins is a common species that seems to have normal association with fishes of the genus *Coregonus*, but in most habitats several other species of fishes seem to serve equally as hosts for this parasite. In Europe, the records of whitefishes similarly consist of a long list of species of Acanthocephala all of which have wide host adaptations. Ciscoes and whitefishes are largely plankton feeders; hence it is not surprising that they fail to show as great consistency in their acanthocephalan parasites as are the fishes that select larger arthropods as food or are of predacious habits.

Parasite surveys have previously demonstrated that heavy infections by worm parasites occur especially in those fishes that feed in shallow waters and particularly in weed beds where intermediate arthropod hosts are brought into intimate and prolonged association with infected fishes. General infection of susceptible arthropod hosts by larval acanthocephalans is thus assured and these same arthropods transmit their parasites back to fishes that feed upon them. In contrast, fishes that are predominantly plankton feeders are not intimately associated with the free-floating plankton organisms, consequently the opportunity for the arthropods to become generally or heavily infected with Acanthocephala is much reduced. Thus the plankton arthropods cannot transmit back to the fishes that feed upon them as heavy or as general infections as are carried back to the fishes that inhabit and regularly feed in shallow waters.

In a number of surveys of fish parasites made in the United States and Canada, the whitefishes and ciscoes have been found free from acanthocephalan parasites peculiar to them (Van Cleave and Mueller, 1934; Bangham and Hunter, 1940; Bangham, 1946). In keeping with the statements made above, in some localities infections with *Leptorhynchoides thecatus* (Linton) have been



FIGS. 26–33.—Morphological features of *Neoechinorhynchus tumidus*, n.sp.: 26–28, Outline drawings of mature paratype females showing characteristic inflation of forepart of trunk and distinctive shape of region where inflated trunk becomes reduced to join neck and proboscis (28) (in all this series the extent of the developing eggs filling the body cavity is shown schematically without attempt to indicate individual eggs and embryos); 29–30, morphological details of paratype males showing individual variation in body shape, Fig. 29 from Waskesin Lake, Saskatchewan, and Fig. 30 from same host species of Trout Lake, Wis.; 31–33, proboscis and its attachment to neck and trunk. Fig. 32 is of holotype female, Figs. 31 and 33 are of paratype individuals.

reported (Bangham, 1941) and heavy infections of *Echinorhynchus coregoni* have been encountered (Bangham and Hunter, 1939). Unpublished records of the occurrence of light infections of *Pomphorhynchus bulbocolli* are likewise available. All three of these are well known and easily recognizable species. Therefore when specimens of a distinctive species of *Neoechinorhynchus* were found in considerable numbers in two different northern localities they aroused immediate interest. A careful study and comparison of these specimens with all known species of Europe and America has demonstrated that they represent a previously unrecognized species which is here described under the name *Neoechinorhynchus tumidus*, n. sp.

In the period from 1928 to 1930, D. S. Rawson made collections of fish parasites from various lakes in the Canadian province of Saskatchewan. He submitted these specimens to the late Prof. Henry B. Ward, who gave the Acanthocephala from ciscoes and whitefishes to one of us (Van Cleave) for identification. Later, specimens from the same hosts were encountered in the extensive surveys of parasites of Wisconsin fishes by Bangham. The latter proved to be identical with the specimens from Saskatchewan and have made possible a fuller analysis of the species than could have been drawn on the basis of the material from Canadian collections alone. Although there are negative records for normal hosts from many localities in Canada and Northern United States, it is probable that *N. tumidus* may have broad geographical distribution in these areas.

Description.—With the characters of the genus *Neoechinorhynchus*. Body of female showing a distinct inflation in the anterior region (Figs. 26, 28). Females having a length of 4 to more than 12 mm, when somewhat compressed in mounting having a maximum diameter in the inflated region of 0.87 to 2.5 mm, rapidly reducing anteriorly to a diameter of about 0.3 to 0.4 mm at the juncture of neck and trunk and posteriorly diminishing to a subcylindrical taillike termination usually under 0.5 mm in diameter. The genital pore commonly a short distance from the posterior extremity (Fig. 26) at the base of a slight postgenital protuberance. Body of males (Figs. 29, 30) shortly cylindrical, lacking anterior inflation characteristic of the females, commonly 3 to 5 mm long with a maximum diameter of 0.7 to 1.5 mm. Neck short, about 40 to 80μ long, an unmodified truncated cone. Proboscis of female (Figs. 31, 32) 172 to 210μ in diameter by 132 to 172μ in length. Terminal hooks 75 to 84μ long with a diameter of 16 to 19μ; hooks of middle circle not conspicuously smaller than those of terminal series, 67 to 79μ, commonly with a slightly sigmoid outward reflection of the point; basal hooks 45 to 53μ long. Proboscis of male slightly smaller than that of female, 158 to 172μ in diameter by 119 to 154μ long. Terminal hooks 69 to 84μ (16–19μ in diameter). Median hooks 67 to 79μ; basal hooks 40 to 53μ. Male genital organs occupy more than one-half the length of the body cavity. Testes and cement glands (Figs. 29, 30) in broad mutual contact; the lemnisci often reaching the level of the posterior testis. Hard-shelled embryos within body cavity of gravid females 36 to 40μ long by 16 to 19μ in width.

Hosts.—In intestine of *Leucichthys artedi* (LeSueur) of Trout Lake, Wis., and of Waskesin Lake, Saskatchewan, Canada, and *Coregonus clupeaformis* (Mitchill) of Waskesin Lake.

Type material.—All material prepared as stained permanent mounts on slides. Holotype female and allotype male from *Leucichthys artedi* (LeSueur) of Trout Lake, Wis. (VC 3812), collected by R. V. Bangham. Paratypes from the same host and same locality as well as from Lake Waskesin, Saskatchewan, Canada, collected by D. S. Rawson in *Leucichthys artedi* (VC 2387) and *Coregonus clupeaformis* (Mitchill) (VC 2390). Holotype and allotype deposited in United States National Museum (Helm. Coll. nos. 37133 and 37134). Paratypes in collection of H. J. Van Cleave, Urbana, Ill., and in that of R. V. Bangham, Wooster, Ohio.

Remarks.—In fully mature females of *N. tumidus*, the anterior region of the trunk is more inflated than in any other species of the genus and is conspicuously distinguishable from the narrowed posterior region of the trunk (Figs. 26–28). The proboscis of *N. tumidus* is smaller than that of *N. crassus* but it is distinctly larger than that of *N. cristatus*, *N. venustus* and *N. rutili*. From species with proboscis of similar size, that of *N. tumidus* is most readily distinguishable by the fact that the hooks of the second series are not conspicuously smaller than those of the terminal series. Usually the hooks of the second series are slightly sigmoidal with the point curved outward away from the proboscis wall.

Neoechinorhynchus doryphorus, n. sp.

Figs. 6–9

When asymmetry in arrangement of the proboscis hooks occurs in the Acanthocephala, it most often finds expression as dorsoventral differentiation of the pattern (Van Cleave, 1941). For the genus *Neoechinorhynchus* most investigators have assumed (Van Cleave, 1939) that radial symmetry is the fixed rule for most species. As early as 1904, Lühe (p. 191) called attention to the fact that the hooks of the so-called terminal circle on the proboscis of *N. rutili* (= *E. clavaeceps*) are actually arranged in two levels, but he was in serious error when he expressed the belief that this constituted a pattern of two circles of three hooks each. Not all species of *Neoechinorhynchus* show this differentiation of the terminal hooks satisfactorily. For *N. emydis* (Leidy), Lincicome (1948) clarified this matter by demonstrating that a single hook on each of the two lateral surfaces of the proboscis is set somewhat posterior to the point of attachment of the two ventral and the two dorsal hooks of the same series. He further emphasized the fact that the two lateral hooks in *N. emydis* are somewhat longer and distinctly heavier than the dorsal and ventral members of the terminal series. These observations constitute the only instance in the Acanthocephala wherein the lateral hooks are distinctively larger than the dorsal and ventral hooks of the same series. A similar distinction has been observed in a few species of the genus *Neoechinorhynchus* from fishes but the degree of difference is usually not as pronounced as observed in *N. emydis* and becomes evident only when the proboscis is mounted so that it can be viewed in full end view since only in such mounts may adjacent hooks be viewed at the same time, without change of focus to disturb the impressions of relative size.

In southern Florida, Bangham (1940, p. 298) discovered an undetermined species of *Neoechinorhynchus* in the flagfish (*Jordanella floridae* Goode and Bean). A study of this material has revealed that the lateral hooks of the terminal series on the proboscis show a degree of differentiation that has been previously unknown for any member of this genus. Not only are the lateral hooks larger and longer than the dorsal and ventral members of the same series, but the right and the left hooks show an extreme expression of asymmetry. One of the laterals (apparently the right) is extremely long and heavy (Fig. 8) while the other is of about the same length but its proximal and distal parts are highly specialized. The proximal region (Fig. 9) forms a broad sleevelike structure through which a fine spinelike blade extends distally. Viewed from either lateral surface the proboscis presents a bizarre asymmetry (Figs. 6, 7) unparalleled in any other species of the entire phylum.

Three of 71 specimens of *Jordanella* carried very light infections with this new species which is here described under the name *Neoechinorhynchus doryphorus*. In a single specimen of *Fundulus majalis* (Walbaum), visceral cysts were encountered. Most of these cysts were occupied by metacercariae of the provisional genus *Neascus*. In the midst of a series of these cysts one chamber, walled by host tissues, contained a single juvenile specimen of *N. doryphorus*.

Only three of the specimens from the flagfish and the juvenile from *Fundulus majalis* (the striped killifish) have the proboscis extruded fully enough to make out complete details of its structure, but in these the pattern is so uniform that the bizarre condition could not be attributed to an abnormality.

Description.—With the characters of the genus *Neoechinorhynchus*. Body of preserved individuals chiefly elongately cylindrical with an increase of diameter near the anterior extremity from which a narrowed truncated cone (about 300μ long; 81 to 92μ wide anteriorly, 115 to 173μ wide posteriorly) makes transition from the widest part of the trunk to the diameter of the narrow neck. Observed individuals 4.38 to 6.4 mm long, enlarged anterior part 289 to 577μ in diameter, the diameter in reduced posterior extremity of the body 289 to 403μ in diameter. Proboscis (Figs. 6, 7) 93 to 132μ wide by 96 to 120μ long. Anterior series of proboscis hooks very prominently distributed as two dorsal, two ventral and two highly modified lateral hooks, one on each lateral surface. Ventral and dorsal hooks of approximately the same size, 61–72μ long with a diameter of 14 to 16μ at their heaviest part. The two lateral hooks of the terminal series (Figs. 8, 9) very conspicuously larger than the dorsals and ventrals and differing markedly from each other in form. Because of twisting of bodies of available individuals it can not be stated definitely if their locations are constantly the same but in two individuals the one on the right side of the proboscis was unmodified (Fig. 8) except for extreme size (105–132μ long with a diameter of 24 to 26μ), while the one on the left side (Fig. 9) was highly modified consisting of an enlarged, sleevelike basal half about 65μ long by 16μ in diameter from the distal extremity of which a fine thorn of about the same length but only about 5μ in diameter protrudes. Hooks of middle series 29 to 32μ long; those of basal series 26 to 32μ. Lemnisci in females obscured by developing eggs, in one male extending to the level of the anterior testis. Male genital organs occupying more than two-thirds the length of the body cavity. Cement ducts long. Subcuticular giant nuclei conspicuous but not causing elevations on surface of body wall. Hard shelled embryos 48 to 55μ by 14 to 16μ wide, with small rounded polar prolongation of the middle membrane.

Host.—Jordanella floridae Goode and Bean of the Englewood area in Florida. Juvenile found once in visceral cyst in *Fundulus majalis* (Walbaum) of the same area.

Type material.—Holotype female, U.S.N.M. Helm. Coll. no. 37136. Allotype male (VC 4189.2) and paratype females in collection of H. J. Van Cleave, Urbana, Ill.; paratype female in collection of R. V. Bangham, Wooster, Ohio.

SUMMARY

A study of new materials of the family Neoechinorhynchidae from fresh-water fishes of Ohio, Florida, Wisconsin, and Canada has revealed four new species, of which one (*Paulisentis fractus*) represents a new genus while the other three are distinctive species of the genus *Neoechinorhynchus* (*N. saginatus*, *N. tumidus*, and *N. doryphorus*, n. spp.). All seem to have distinctive host relationships.

Speciation in the family Neoechinorhynchidae, paralleling evolutionary progress of the hosts in fresh-water fishes of North America, is expressed at two different levels. At the lower of these, distinct species are differentiated. At a higher level, quantitative and qualitative morphological changes make their appearance in structures which taxonomists have come to regard as capable of reflecting generic distinctions. There is no evidence of the degree of diversification expressed by the host being directly paralleled by the degree of diversification of its parasites, since in the same host species a unique genus and a peculiar species have been found existing in the same species of host at the same time.

In the creek chub, *Semotilus atromaculatus atromaculatus* (Mitchill), of Ohio streams, *Paulisentis fractus*, n.gen., n.sp. occurs, while in the same host species from Wisconsin a characteristic species of *Neoechinorhynchus*, *N. saginatus*, n.sp., is recognized.

N. tumidus, n.sp., is described from *Leucichthys artedi* (LeSueur) of Trout Lake, Wis., and from the same host in Waskesin Lake, Saskatchewan. In the latter habitat, *Coregonus clupeaformis* (Mitchill) is likewise its definitive host.

N. doryphorus, n.sp., from the flagfish (*Jordanella floridae* Goode and Bean) is described from Florida in the Englewood area. This species has the most pronounced diversification of the lateral hooks of the terminal series that has ever been observed for any member of the entire phylum. It far exceeds the differentiation found in *N. emydis* since it involves entirely different types of morphological modifications for the median hook on each of the two lateral surfaces of the proboscis.

NOTE ON ILLUSTRATIONS

All figures were drawn from stained whole permanent mounts with the aid of a camera lucida. Katharine Hill Paul, scientific artist in the Department of Zoology of the University of Illinois, executed all the drawings and arranged the plates.

SYMBOLS

B—copulatory bursa
C—cement gland
G—giant subcuticular nucleus
L—lemniscus
O—terminal organ of proboscis
P—proboscis
R—cement reservoir
T—testis
I to V—series of proboscis hooks

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HERPETOLOGY.—*Notes on a collection of reptiles and amphibians from the Isthmus of Tehuantepec, Oaxaca.*[1]

Hobart M. Smith and Dave A. Langebartel, University of Illinois. (Communicated by Herbert Friedmann.)

During late 1948 and early 1949, Thomas MacDougall, aided by a number of local residents of Tehuantepec, secured a series of 40 unusually noteworthy specimens of reptiles and amphibians in the vicinity of the Isthmus of Tehuantepec. These are now in the Museum of Natural History of the University of Illinois, to which all specimen numbers cited in the following discussion refer. We are much indebted to Mr. MacDougall for his kindness in accumulating this material under difficult circumstances and for providing detailed information regarding habitats and localities.

Especially noteworthy in this collection of 21 species are a new species of *Ficimia* and another of *Rhadinaea*, two new State records (*Leiolopisma cherriei stuarti* and *Coniophanes fissidens fissidens*), and two aberrant specimens of *Pliocercus e. elapoides* and *Micrurus ephippifer*. All these except the last were obtained in the little-explored area north of Niltepec. If, as was the case, six specimens from this region proved to be of such novel interest, the area must be one that would well repay more intensive exploration. It is unfortunate that the area is so difficult of access.

Localities from which the specimens were taken, all within the state of Oaxaca, are not all readily found on maps generally available. The following list is given of those not on the American Geographical Society's 1938 map of the area, scale 1:1,000,000 (distances straight-line, unless otherwise stated):

Cerro Calderona: 3 miles north-northeast of Matías, about 13 (15 by trail) miles west-northwest of Tehuantepec; north of Cerro San Pedro.

Ranchería Santa Lucía: About 15 (20 by trail) miles west-southwest by west of Tehuantepec.

Escurano: Lower slopes of Cerro San Pedro, about 15 miles west-northwest of Tehuantepec.

La Gloria: 30 miles north of Niltepec; about 50 miles northeast of Tehuantepec.

Nisabibi: 2 miles west of Yerba Santa near foot of Cerro San Pedro.

Portillo Guayabo: 16 miles due west of Tehuantepec.

Río Grande: 15 miles north of Niltepec, and 1–2 miles downstream from Scarces; 50 miles northeast of Tehuantepec.

San Pablo Topiltepec: 55 miles west-southwest of Tehuantepec (about 85 miles by trail).

Santo Tomás Teipan: 49 miles (about 65–70 miles by trail) west-southwest of Tehuantepec (listed as Teipam on map).

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[1] Contribution from the Museum of Natural History and Department of Zoology, University of Illinois, Urbana. Received July 26, 1949.

Thorius minutissimus Taylor

"Six topotypic specimens (nos. 3754–59) are from the small, isolated area of cloud forest at Santo Tomás Teipan (cited incorrectly as 'Tecpan (S. Tomás)' on some maps). Two possess two premaxillary teeth penetrating the lip. The largest specimen measures 22 mm from snout to vent. The nostril is relatively small, and the subnarial swelling reduced in all. The chief feature distinguishing this species from *narisovalis* apparently is the markedly greater extent of fusion of the digits. The eyelids are darkened. The number of caudal grooves apparently is not significant; our three specimens with complete tails have 31, 34, and 35 caudal grooves." (Quotation from Taylor, in letter.)

Mabuya mabouya mabouya (Lacépède)

Two adult specimens (nos. 3760–61) are from Nisabibi, both collected on March 25, 1949. The specimens are typical with a dark lateral stripe bordered below by a sharply defined light line, above by a poorly defined light line; one pair of nuchals; 4 supraoculars; fifth supralabial subocular in position; supranasals separated; prefrontals separated; parietals in contact; scales around middle of body 28, 30; scales from chin to vent, 59, 60; toes overlapping when adpressed. The specimens measure 67 and 73 mm, respectively, from snout to vent.

Leiolopisma cherriei stuarti (Smith)

A single adult (no. 3762) is from the Pacific slopes of the main ridge of the Sierra Madre between Río Grande and La Gloria, elevation about 3,000 feet, in pine stands. The interparietal is single, the scale rows at midbody 30, the dorsals from parietal to base of tail 69, the tail of a slightly bluish cast. The specimen measures 50 mm from snout to vent, the tail 93 mm.

The dorsal scale count, in which lies the chief difference between *L. c. cherriei* and *L. c. stuarti*, is 69 in this specimen and thus clearly refers the specimen to *L. c. stuarti*, in which the dorsal counts average 69.1 (range 65 to 72). In *L. c. cherriei* the counts average 63.2 and vary from 59 to 67.

This race has not previously been recorded in the state of Oaxaca. The present specimen extends the known range from the foothills of central Veracruz across the Isthmus of Tehuantepec to extreme eastern Oaxaca—a distance of about 300 miles. Although the species was to be expected to occur in the state of Oaxaca, presumably inhabiting all the foothills from Córdoba, Veracruz, to Palenque, Chiapas (between which localities no specimens have previously been recorded), the subspecific ranges were entirely a matter of conjecture. As a matter of fact the race to be expected in the area represented by the present specimen was *L. c. cherriei*, because of apparently closer zoogeographic affinity of this area and the known limits of the range of the race.

Gymnophthalmus sumichrasti (Cope)

A single, somewhat mutilated adult (no. 3763) is from Escurano. The mental is in contact with two large postmentals, which are broadly in contact medially and followed by a similar pair; 4 supralabials to rear margin of eyes; dorsals 33; scale rows at midbody 13; femoral pores 5–5; 38 mm from snout to vent; tail 61 mm; tail a light tan, body dark brown above.

Heloderma horridum Wiegmann

A single half-grown specimen (no. 3764) is from La Concepción, taken on March 19, 1949. It measures 215 mm from snout to vent, the tail 196 mm. The pattern is typical, predominantly of black but with prominent yellow areas.

Dryadophis melanolomus tehuanae Smith

A single subadult male (no. 3765) is from Cerro Calderona, collected on August 29, 1948. Scale rows 17–17–15; ventrals 181; caudals 109; supralabials 9–9; infralabials 10–10; preoculars 1–1; postoculars 2–2; temporals 1–2 on one side (normal), 2–2 on the other (abnormal, with two tiny upper anterior temporals in succession, bordering above the large lower anterior temporal); total length 805 mm, tail 240 mm.

Drymarchon corais melanurus (Duméril, Bibron, and Duméril)

One specimen (no. 3766), from La Gloria, March 9, 1949, is referred to this subspecies in spite of the fact that it belongs to the wide-ranging "intergrade" populations between *D. c. melanurus* and *D. c. rubidus*. The specimen, a juvenile male, measures 700 mm in total length, the tail 134 mm; scale rows 19–17–15; ventrals 192; caudals 82; supra- and infralabials 8–8; preoculars 1–1; postoculars 2–2; temporals 2 + 2, 2 + 2; antepenultimate labial in contact with temporal.

In spite of the derivation of this specimen from Atlantic slopes where typical *D. c. melanurus* might be expected, the snake appears to agree perfectly with the so-called intergrades between *D. c. melanurus* and *D. c. rubidus* described by Smith (Journ. Washington Acad. Sci. **31:** 476. 1941). The dorsal surface, except on the tail, is relatively light (as in *melanurus*); the first preocular labial (i.e., the third supralabial) possesses a dark posterior border (intermediate); the lateral gulars have slightly darkened tips (as in *rubidus*); many ventrals have a distinct dark posterolateral mark on each side (as in *rubidus*); the light transverse dorsal bands appear to be but one scale wide (as in *rubidus*); the head is light, and the labials appear to be pale brown (as in *melanurus*).

Ficimia ramírezi,[2] n.sp.

(Fig. 1, *right*)

Type.—No. 3767, an adult male, collected by Juan Ramírez 1 league north of Niltepec, Oaxaca, March 6, 1949.

Diagnosis.—A member of the genus *Ficimia*, with 20 poorly defined chocolate-brown blotches on back, separated from one another by spaces two to three times their own length, very incompletely bordered with black; no dark markings on head; two internasals; two postoculars; ventrals 136, caudals 38 in single known male.

Description of type.—Rostral large, in contact with frontal, suture with latter one-half maximum width of rostral; internasals well developed, about size of preocular; anterior half of nasal fused with 1st supralabial; prefrontal broadly in contact with second supralabial; 1–1 preoculars; 2–2 postoculars; eye relatively large, its vertical diameter equal to its distance from labial border, its longitudinal diameter one-fourth longer; temporals 1–2, the anterior elongate, the secondaries similar in shape to dorsals; frontal as long as broad, equally as long as its distance from tip of snout; supralabials 7–7; infralabials 7–7, the anterior 3 in contact with chinshields; 1 pair of chinshields.

Dorsals in 17–17–17 rows, smooth even in supraanal area, each with a single apical pit; ventrals 136, caudals 38; total length 325 mm, tail 54.

Hemipenis 10 caudals long, simple and with simple sulcus; 2 large basal spines; spines occupying basal third, becoming smaller distally and merging with calyces; several longitudinal plicae extending through both spinous and calyculate zones.

Dorsal color a light slate; head tan above; 20 light chocolate brown blotches on body, each 1½ to 2 scales in length, 5 to 8 scale rows wide, separated from one another by spaces two to three times as long as the blotches; a very incomplete black border on the blotches; some blotches,

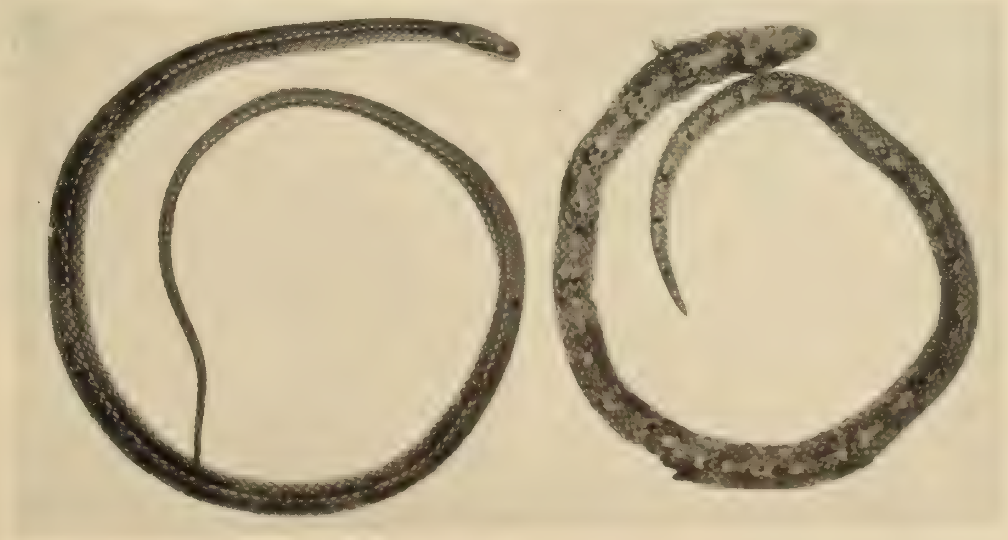

Fig. 1.—*Left: Rhadinaea macdougalli*, n. sp., holotype. *Right: Ficimia ramírezi*, n. sp., holotype.

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[2] Named for Sr. Juan Ramírez, a resident of Tehuantepec, who collected the type and assisted the senior author when visiting the Tehuantepec area nearly 10 years ago and who has for 15 years or more faithfully aided Thomas MacDougall in carrying out intensive field work in the Tehuantepec area.

especially toward rear of body, preceded and succeeded by a small, poorly defined light spot on the midline; a few scattered, dark lateral streaks; median dorsal blotches showing a tendency to have the lateral edges split off (as typical of most species of this genus); 8 dorsal blotches on tail; ventral surfaces immaculate; no markings on head.

Remarks.—The present species differs remarkably in pattern from all other species of the genus. While *publia* is known to have as few as 21 blotches, they are approximately as broad as the interspaces, while in *ramírezi* the anterior blotches are separated by interspaces twice their own length, the interval gradually increasing posteriorly to three times as the blotches decrease in size. This feature of the pattern is not approached by other members of the genus. Other features distinguishing this specimen from *publia* is the absence of lateral blotches and of any pattern on the head.

The derivation of this specimen from an area where *publia* is to be expected casts some doubt upon its validity. Only further specimens can prove beyond reasonable doubt the validity of the supposed species. Certainly a sufficient number of unique features in pattern occur in the type of *ramírezi* to warrant the provisional assumption of the existence of a distinct species.

Ficimia publia publia Cope

Two specimens, the twenty-first and twenty-second known of this subspecies, are available; one (no. 3768) is from La Concepción, collected on March 19, 1949, while the other (no. 3769) is from Portillo Grande, collected on July 26, 1948. Respectively the dorsals are in 18–17–17, 17–17–17 rows; ventrals 154, 137; caudals 35 (♀), 38 (♂); infralabials 8–8, 7–8; temporals 1 + 2, 1 + 2/1 + 1 + 2; spots on body 27, 23; spots on tail 8, 8; total length 262, 199 mm; tail 38, 32 mm. Both agree in having 7–7 supralabials, 1–1 preoculars, 2–2 postoculars, and 1–1 internasals.

Especially noteworthy is the fact that in the specimen with relatively few blotches (23) on the body (21 is the minimum known) the spots are large, well defined, at least a third longer than, and often twice as long as the interspaces; in other words no approach to the condition occurring in *ramírezi*, in which the interspaces are two to three times as long as the blotches, is indicated.

Manolepis putnami (Jan)

A single young female (no. 3770) is from San Pablo Topiltepec, collected early in 1949. It has 19–19–15 scale rows, 181 ventrals, 75 subcaudals, 8–8 supralabials, 10–10 infralabials, 1–1 preoculars, 2–2 postoculars, 1–2–2 temporals, no loreal, total length 256 mm, tail 53 mm.

Pliocercus elapoides elapoides Cope

A single juvenile female (no. 3771), was collected in rain forest between Río Grande and La Gloria (4,000–4,500 feet elevation), March 7, 1949. It has 17–17–17 scale rows, 130 ventrals, 93 caudals, 8–8 supralabials, 9–9 infralabials, 2–2 preoculars, 2–2 postoculars, 7 primary black rings on body (all complete), 5 on tail; total length 200 mm, tail 71 mm. The black borders of the yellow rings are much wider than the yellow rings both on body and tail.

Two unusual features, both in pattern, are noteworthy: (1) a black middorsal band extends the length of each red zone, connecting the two black borders of that zone with each other; and (2) the parietal yellow ring is completely interrupted on the top of the head for a width about equal to that of a frontal. The reduced number of primary rings is likewise very unusual for *e. elapoides*. Despite the magnitude of these discrepancies it is impossible to determine their significance in the absence of further specimens from the Pacific coast and Isthmus areas. The specimen was taken in rain forest very near the crest on the Pacific slope of the Sierra Madre which lies between Río Grande, on the Pacific side, and La Gloria on the Atlantic.

Enulius unicolor (Fischer)

A single adult male (no. 3772) is from the vicinity of Tehuantepec. It has 17 scale rows throughout the length of the body; 174 ventrals, 67 caudals (tail tip missing); 7–7 supralabials; and infralabials; no preoculars; 2–2 postoculars 1–2, 1–2 temporals; snout to vent 220 mm, tail 85 mm (incomplete).

Tantilla rubra Cope

Two specimens are available. One (no. 3773) is a juvenile female from Cerro San Pedro, collected on January 20, 1949, the other an adult male (no. 3774) from Tehuantepec, collected early in 1949. Respectively they have 155, 147 ventrals; caudals 59, 51+; total length 195 mm, 330 + mm; tail 43 mm, 67 + mm. Both agree in having 7–7 supralabials and infralabials, 1–1 preoculars, 2–2 postoculars, and 1–1 temporals. The two anterior infralabials are in contact medially in each, and the yellow nuchal ring barely involves the tip of the parietals in one, clearly does so in the other. Coloration typical.

Rhadinaea macdougalli,[3] n.sp.

Fig. 1, *left*

Type.—No. 3775, male, collected by Thomas MacDougall on March 7, 1949, near Buena Vista, at crest of Sierra Madre, 4,000–4,500 feet, directly north of Río Grande, Oaxaca.

Diagnosis.—A member of the genus *Rhadinaea*, with 17 scale rows, ventrals about 119, caudals about 75, in males; no supraanal keels; maxillary teeth 16 + 2, with a short but well-defined diastema preceding the two rear teeth; hemipenis capitate, sulcus divided, with about 22 large spines in a belt around the middle, and numerous fine spines to base. Sides below upper part of fourth scale row darker than back, faintly bordered above by a light line; no other stripe on body; head with a light line through the supralabials and another from upper rear margin of orbit to upper edge of last supralabial; belly immaculate except ends of ventrals, which are darker than adjacent dorsal scales.

Description.—Portion of rostral visible from above two-thirds length of median internasal suture; latter entering 2½ times into median prefrontal suture; frontal a little longer than its distance from tip of snout; nasal large, completely divided; loreal square; 3 preoculars and 2 postoculars on each side; temporals 1–2–3; eye large, its longitudinal diameter entering 1⅓ times in its distance from tip of snout, one-half time in its distance from labial border; 8 supralabials, fourth and fifth entering orbit, seventh largest; 10 infralabials, 5 in contact with anterior chinshields, 2 with posterior; anterior chinshields a little shorter than posterior, the members of each pair in contact throughout their length.

Dorsals in 17 rows throughout body; scales absolutely smooth even in supraanal area, pitless; ventrals 119, subcaudals 75; anal divided.

Maxillary teeth 16 + 2, steadily increasing in size posteriorly to the sixteenth, the anterior one about two-thirds length of sixteenth; rear two teeth abruptly enlarged one-fourth more than preceding tooth.

Hemipenis single, 8 caudals long, capitate, calyculate, sulcus dividing opposite 6th caudal; a belt of 22 large spines of various sizes around middle third of hemipenis, below calyces; numerous minute spines on basal third of hemipenis, which appears to be provided with longitudinal ridges; some minute spines also scattered among large spines.

Total length 294 mm; tail 106 mm.

Dorsal color a nearly uniform dull, dark brown; edges of each scale darker than middle; sides a little darker than middorsum, the darker color abruptly terminating at a moderately distinct black line on upper part of fourth scale row; centers of scales in fifth scale row not as dark but lightly stippled, giving the effect of a faint light line; rest of dorsum uniform. Head light brown above, little stippled with darker; a sharply defined white line extending from upper rear corner of eye through temporals to upper edge of last supralabial, there abruptly terminating, partly on the labial and partly on the scale immediately above; another white line through rostral and across upper edges of the fifth and preceding supralabials, through the middle of the sixth, barely involving the anteroventral corner of the eighth, where it ends at the lip; both white stripes bordered by broad black lines, continuous except for that below the supralabial line which is interrupted at each labial suture, producing the effect of a row of spots on the lower edges of the labials, one spot to each scale. Dorsolateral light line of body rather distinct as it nears head, curving laterally toward temporal stripe, but terminating abruptly in a rounded, black-edged, small expansion which fails to reach the end of the temporal stripe by two scale lengths; a dark spot on each of the anterior four infralabials, two on the mental, and one on each anterior chinshield at its anterior end; a few flecks in lateral gular region. Ventrals and subcaudals entirely immaculate, white, except the extreme lateral ends which anteriorly are black tipped, elsewhere brown as the sides of the body and tail.

Remarks.—The relationships of this distinct species are difficult to determine. Of the Mexican species now known only the recently described *R. marcellae* Taylor (Univ. Kansas Sci. Bull. **33**: pt. 1 (2): 197, 1949) appears to be related. None of the Central and South American species appear the same. Taylor's species, based upon a male (Taylor, correspondence) possesses only 2 preoculars, a nuchal collar, a dorsal scroll-like pattern on the head, only 4 infralabials touching anterior chinshields, 8–9 infralabials, a quadrangular loreal, etc. (in *macdougalli,* 3 preoculars, no nuchal collar, no scroll-like pattern on head, 5 infralabials touching anterior chinshields, 10 infralabials, a square loreal). These differences are relatively minor, and point toward a close relationship between *marcellae* and *macdougalli.* In a way the two species seem somewhat intermediate between the isolated *decorata* and the *taeniata—quinquelineata* groups, having the low ventrals and certain features of the dorsal pattern of the former, but the low caudals and certain features of the head pattern of the latter. The species are not related, apparently, to the enigmatical *Erythrolamprus mentalis* Werner, which

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[3] Named for Thomas MacDougall, collector, who for 10 years has assisted the senior author to become acquainted with the Tehuantepec area.

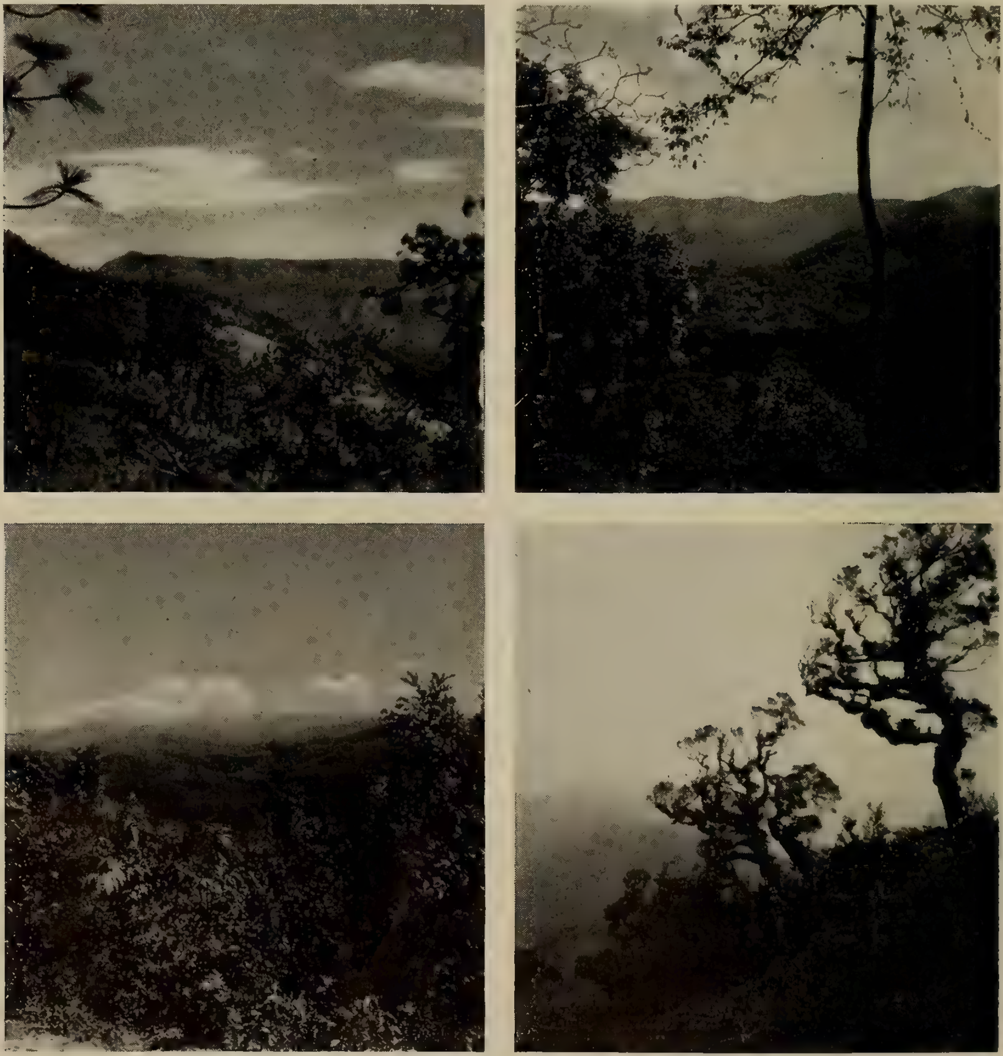

FIG. 2.—*Upper left:* Dry Pacific (southern) slopes of the Sierra Madre north of Niltepec, Oaxaca, on the trail from Río Grande to La Gloria, looking eastward toward Cerro Atravesado, which extends in a north-south direction. *Upper right:* View toward east, paralleling the Sierra Madre, from La Gloria. *Lower left:* View toward south from Santa María Chimalapa, on the Río Coatzacoalcos and not far from La Gloria; the Sierra Madre is in the distance, the highest peak (just to the right of which the Río Grande–La Gloria trail crosses) slightly to right of center. *Lower right:* Northern slope of the Sierra Madre north of Niltepec on the trail from Río Grande to La Gloria. Photos courtesy of Thomas MacDougall.

Table 1.—Variation in Leptodeira maculata

No.	Sex	Scale rows	Ventrals	Caudals	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Dorsal and caudal blotches	Total length	Tail length
										Mm	*Mm*
3781	♂	21–23–17	174	72	8–8	9–9	1–2	2–2	26+12	525	109
3782	♂	19–23–17	174	—	8–8	10–10	2–2	2–2	27+—	450+	47+
3780	♂	21–23–17	176	71	8–8	10–10	2–2	2–2	29+—	535	113
3779	♂	21–23–17	170	71	9–9	10–10	2–2	2–2	29+13	508	109
3786	♂	21–22–17	173	—	8–8	10–10	—	—	28+—	419	74
3784	♂	21–23–17	176	71	8–8	10–10	2–2	2–2	29+—	535	113
3783	♀	23–25–17	177	66	8–8	10–10	2–2	2–2	31+13	395	80
3785	♀	23–25–17	172	67	—	—	2–2	2–3	29+12	362	74

has 147 ventrals, 1 preocular and a very different color pattern.

Coniophanes imperialis copei Hartweg and Oliver

A single specimen (no. 3776) is from La Finca (Tehuantepec), collected on April 2, 1949. It is a typical subadult female measuring 231 mm snout to vent (tail broken); scale rows 19–19–17; ventrals 130; supralabials 8–8; infralabials 9–9; preoculars 1–1; postoculars 2–2; temporals 1–2, 1–2. The dorsal stripe is very narrow and continuous, and the lateral dark stripe is distinctly darker on its upper half.

Coniophanes fissidens fissidens (Günther)

One specimen (no. 3777) is from La Gloria. It is a subadult male with anal ridges; scale rows 21–21–17; ventrals 126; caudals 78; supralabials 8–8; infralabials 10–10; preoculars 1–1; postoculars 2–2; temporals 1–2, 1–2; 435 mm total length; 137 mm tail length. Generally one, occasionally 2 distinct dark spots, about 0.5 mm in diameter, at end of each ventral and on each subcaudal; no dark dorsal spots such as occur in *C. f. punctigularis;* median dark border of dorsolateral light stripes confined to tail, not present on rear part of body; whitish portion of dorsolateral light stripes back of head relatively short, little more than twice length of head.

This subspecies has never before been recorded from the state of Oaxaca, although its occurrence in this poorly known, humid Atlantic exposure was to be expected. The specimen definitely does not agree with others (Mus. Comp. Zool. nos. 27702–18, *C. f. dispersus*) from Tapanatepec on the Pacific slopes of the Isthmus only 40 miles distant. The two localities, however, are in very markedly different zoogeographic areas.

Imantodes splendidus oliveri Smith

One female (no. 3778) is from Nisabibi, collected on March 25, 1949, and another female (no. 4001) is from Tehuantepec. Respectively they have 17–17–16, 17–17–17 scale rows; 220, 230 ventrals; 121, 129 caudals; 9–9, 8–8 supralabials; 10–10, 10–? infralabials; 1–1 preoculars, 2–2 postoculars, 1–2 temporals; supralabials 4–5–6, 3–4–5 entering orbit; 57, 59 bands on body; all bands broken laterally except on anterior third, two-fifths of body; total length 431, 440 mm; tail 113, 120 mm.

Leptodeira maculata (Hallowell)

Eight specimens are in the collection. Two (nos. 3779–80) are from Nisabibi, four (nos. 3781–4) from Tehuantepec, one (no. 3785) from Cerro Santa Lucía, and one (no. 3786) from Cerro Calderona. Variation in certain characters is given in Table 1.

Leptodeira mystacina Cope

Two adult females are available: No. 3787, from Escurano, collected on July 30, 1948, and no. 3788, from La Concepción, collected on March 18, 1949. Respectively the ventrals are 192, 186; subcaudals 64–61; supralabials 7–8, 8–8; infralabials 9–10, 10–10; dorsal bands 11, 13 on body, 5, 5 on tail. Both agree in having 19–19–17 scale rows, 1–1 preoculars, 2–2 postoculars, 1 + 2 temporals.

Stenorrhina freminvillii freminvillii Duméril, Bibron, and Duméril

Two specimens are in the collection: No. 3789 from Escurano, March 9, 1949, and no. 3790 from Cerro San Pedro, January 13, 1949. Respectively, ventrals are 171, 166; subcaudals 32, 44; temporals 2 + 2 (anomalous), 1 + 2; total length 430, 170 mm; tail length 54, 25 mm. Both agree in having 7–7 supralabials and infralabials, 1–1 loreals, 1–1 preocular, 2–2 postoculars, 17 scale rows throughout length of body, anterior half of nasal fused with internasal. Despite the great difference in size between the specimens, the coloration is virtually identical and is indicated as essentially constant throughout life. The body is salmon-pink above, a little lighter below; a very faint middorsal dark streak in the adult, well defined and one-half a scale row wide in the juvenile; a dark line through eye, faintly continued along sides between the third and fourth scale rows.

Micrurus ephippifer Cope

Two specimens are in the collection. One is a typical female (no. 3791) from La Concepción, collected March 20, 1949. It measures 470 mm in total length, the tail 53 mm (ratio, tail to total length, 0.113); scale rows 15–15–15; ventrals 221; caudals 42; supralabials 7–7; infralabials 6–6; preoculars 1–1; postoculars 2–2; temporals 1–1, 1–1; primary black rings on body 22, on tail 5 (not counting black tip); red zones replaced by black on most of dorsal scale rows, ventrally to the first scale row or edge of ventrals; ventrals rather extensively marked with black in red zones, so that from one-half to one-sixth the area is occupied by black in any one zone; red zones 2–7 ventrals long, usually 4; yellow rings 1 or 2 ventrals long, usually 1; black rings 4–5 ventrals long, usually 4; black nuchal ring extending 6 scale lengths back of parietals, the posterior tips of which are involved; yellow parietal ring not reaching anterior edge of parietals, barely touching posterior tip of frontal; red rings usually forming a very narrow fringe in front of and behind the black dorsal blotch.

The other specimen (no. 3792) is an adult male from Nisabibi, collected on March 28, 1949. It is most extraordinary in the great reduction in number of all rings, and the restriction of the dorsal black blotches of the red rings to the area between the third, fourth, or fifth scale row of each side. The scale rows are 15–15–15 and without any evidence whatever of supra-anal tubercles or keels; ventrals 218; caudals 56; supralabials 7–7; infralabials 6–6; preoculars 1–1; postoculars 2–2; temporals 1–1, 1–1; black rings on body 13, on tail 4 (not counting black tip); total length 695 mm, tail length 105 mm (ratio tail to total length, 0.151). Yellow rings relatively wide, as frequently 2 ventrals long as 1; black rings 5–7 ventrals long, usually about 6; red rings 8–10 ventrals long, usually 9; black dorsal saddles in red rings 7 scales in length on anterior half of body, 6 on posterior half, completely interrupting red rings anteriorly but failing to do so on posterior half of body; half of black saddles extending laterally onto fourth scale row, half only onto fifth; nuchal black ring covering 9 scale lengths, barely touching posterior tips of parietals; each red ring with a few small scattered black flecks both above and below.

The aberrant specimen possesses fewer black rings (13) on the body than any other specimen reported. The nearest approach is a record (Woodbury and Woodbury, Journ. Washington Acad. Sci., **34:** 371. 1944) of a specimen with 16 black rings. The low number is not sexually significant, as a male from Llano Ocotal (EHT no. 27533) possesses 21 black rings. Other specimens have been reported with from 18 to 23 black rings. While the indicated range of variation, 13 to 23, is extraordinarily large, it is matched by another species, *M. nigrocinctus browni*, in which the range is 11 to 24.

In view of (1) the absence of differences other than pattern from more typical *M. ephippifer;* (2) the existence of at least one intermediate of 16 between the extremes of 13 and 18–23 of the counts for black rings; (3) the derivation of the questioned specimen from the same area from which more typical *M. ephippifer* has been obtained; and (4) the occurrence of an even greater range of variation in black-ring count in at least one other species of the genus than would be obtained by placing this specimen with *M. ephippifer*, we regard it highly improbable that the present specimen represents a species other than *M. ephippifer.*

MAMMALOGY.—*Two new wood rats from eastern Utah.*[1] KEITH R. KELSON, University of Utah. (Communicated by HERBERT FRIEDMANN.)

A study of variation in rodents from the Colorado River drainage of Utah revealed that certain populations of wood rats of the species *Neotoma cinerea* and *Neotoma lepida* were sufficiently differentiated from known subspecies to warrant separation and naming. I am indebted to Stanley P. Young and the U. S. National Museum for the loan of comparative material and to the University of Utah Research Council for financial assistance in obtaining the specimens reported upon here. Unless otherwise indicated, all specimens are in the collection of the Museum of Zoology, University of Utah. Measurements are given in millimeters.

Neotoma cinerea macrodon, n. subsp.

BIG-TOOTHED WOOD RAT

Type.—Male, adult, skin and skull, no. 4725, Museum of Zoology, University of Utah, east side of the confluence of Green and White Rivers, 1 mile southeast of Ouray, 4,700 feet, Uintah County, Utah; August 21, 1946; collected by Keith R. Kelson, original number 120.

Range.—Known only from the northern edge of the East Tavaputs Plateau, Uintah County, Utah.

Diagnosis.—Size small (see measurements); hind foot small; tail short (ratio of tail length to head-body length averaging 74.7 percent in a series of 4 adult ♂♂). Color (capitalized color terms after Ridgway, *Color standards and color nomenclature*, Washington, 1912): Upperparts Pale Ochraceous-Buff grading to Light Ochraceous-Salmon on cheeks, shoulders and flanks, thinly overlaid with blackish hairs, underparts white; feet white above; tail distinctly bicolored, dusky above and white below except for a buffy basal band, distal two-thirds narrowly edged with buffy-tipped hairs. Skull: Small, moderately angular; frontonasal region slightly arched, moderately channeled above; temporal ridges well developed and widely separated; interparietal broad between temporal ridges, but relatively short; sphenopalatine vacuities large; auditory bullae moderate in size; alveolar length of upper molar series long and individual teeth large; upper incisors weak.

Measurements.—Average and extreme measurements of 4 ♂♂ and measurements of 2 ♀♀, nos. 6660 and 5893 (the latter showing little tooth wear) are, respectively, as follows: Total length, 348.5 (372–333), 330, 292; length of tail vertebrae, 146 (158–139), 140, 120; length of hind foot, 38.3 (40–36), 39, 37; basilar length, 39.2 (42.1–37.6), 37.4, 35.8; length of nasals, 18.3 (20.6–17.1), 16.9, 16.4; length of incisive foramina, 10.5 (11.6–9.7), 9.9, 10.1; length of palatal bridge, 9.0 (9.4–8.5), 8.4, 7.7; zygomatic breadth, 24.1 (26.2–22.5), 23.2, 21.0; alveolar length of upper molar series, 9.8 (10.1–9.6), 9.7, 9.4.

Comparisons.—From *Neotoma cinerea acraia*, *N. c. macrodon* differs as follows: Tail shorter, hind foot shorter. Color: Generally much lighter, but certain specimens of *N. c. acraia* from the High Plateaus of central Utah are indistinguishable from *N. c. macrodon* in this respect. Skull: Less angular and smaller; frontonasal region less deeply channeled above; cranial roots of the zygomata weaker; sphenopalatine vacuities large as opposed to absent; interparietal usually shorter; auditory bullae less inflated ventrally; upper molar tooth row 7 percent longer; upper incisors less robust.

From *N. cinerea orolestes*, *N. c. macrodon* differs as follows: Size slightly smaller. Color: Markedly lighter. Skull: Frontonasal region less deeply channeled above; sphenopalatine vacuities slightly larger; upper molar tooth row 8 percent longer; zygomatic arches heavier; frontonasal region more arched.

From *N. cinerea arizonae* which it most closely resembles, *N. c. macrodon* differs as follows: Color: Markedly lighter, being buffy rather than tawny, tail duskier above and bushier. Skull: Similar, except the length of the upper molar series is 16 percent longer in comparable male specimens sphenopalatine vacuities larger.

Remarks.—The presence of large sphenopalatine vacuities indicates that *N. c. macrodon* belongs to the same group of wood rats as *N. c. orolestes*, *N. c. arizonae*, and *N. c. rupicola*. Specimens are still too few to ascertain the phylogenetic relationships of the new subspecies with other subspecies of the same complex. The pallid color of *N. c. macrodon* is noteworthy since several kinds of mammals from the same general region are also noticeably paler than related subspecies elsewhere. This is most apparent in *Perognathus apache caryi* and *Lagurus curtatus levidensis.*

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[1] Contribution from the Department of Vertebrate Zoology, University of Utah, Salt Lake City, Utah. Received July 25, 1949.

The designation of the bushy-tailed wood rats from the East Tavaputs Plateau (and, presumably, the southern part of the Uinta Basin) as subspecifically distinct leaves a single specimen in the collections of the University of Utah, no. 967, from Castle Valley, 18 miles northeast of Moab, 6,000 feet, Grand County, as the northernmost known record of *N. c. arizonae* in Utah. This specimen closely resembles topotypical and near topotypical specimens of that subspecies. Two specimens from Vernal, Uintah County (U. S. National Museum), and a single skull, no. 7098, sex unknown, from Myton, Duchesne County, show no intergradation with *N. c. macrodon.* These specimens are best referred to *N. c. orolestes.* Both of these localities are on the opposite side of the Green River.

Specimens examined.—Seven, all from Uintah County, Utah: East side of confluence of Green and White Rivers, 1 mile southeast of Ouray, 4,700 feet, 4; Willow Creek, 25 miles south of Ouray, 5,250 feet, 2; Willow Creek 29 miles south of Ouray, 5,400 feet, 1.

Neotoma lepida sanrafaeli, n. subsp.

San Rafael Wood Rat

Type.—Male, adult, skin and skull, no. 6428, Museum of Zoology, University of Utah, Rock Canyon Corral, 5 miles southeast of Valley City, 4,500 feet, Grand County, Utah; June 20, 1948; collected by Keith R. Kelson, original number 522.

Range.—Eastern Utah between the Colorado River and the High Plateaus, north to the Book Cliffs, south to northern Garfield County.

Diagnosis.—Size small (see measurements); hind foot and tail average for the species. Color: Ground color of upperparts Light Buff to Light Ochraceous-Buff with wash of blackish; cheeks, flanks and shoulders Light Ochraceous-Buff; upperparts of feet white; underparts white, with hairs plumbeous basally except on pectoral, and inguinal regions and on a narrow strip of the belly; tail distinctly bicolored, white below except for a buffy basal band, and dusky above, black hairs being mixed with buffy, the former predominating distally. Skull: Comparatively large, ridged, and angular; frontonasal region slightly arched; moderately furrowed above with well developed supraorbital ridges; temporal ridges well developed; sphenopalatine vacuities moderate; palatal bridge long; upper molar series long and wide.

Measurements.—Measurements of the type, and average and extreme measurements of 5 adult ♂♂, and 1 adult ♀, no. 6429, from the type locality are, respectively, as follows: Total length, 312, 288 (312–267), 300; length of tail vertebrae, 128, 119 (128–115), 129; length of hind foot, 34, 31 (34–28). 31; (cranial measurements are based on 4 adult males) basilar length, 34.2, 33.9 (35.1–32.7), 32.8; length of nasals, 15.1, 14.7 (15.1–14.5), 14.7; length of incisive foramina, 8.5, 8.5 (9.1–8.2), 8.3; length of palatal bridge, 7.7, 7.45 (7.7–7.1), 7.7; interorbital breadth, 5.1, 5.3 (5.4–5.1), 5.3; extension of premaxillary tongues posterior to nasals, 3.2 2.8 (3.2–2.4), 2.5; zygomatic breadth, 21.7, 20.9 (21.7–20.3), 20.7; width of brain case, 16.2, 16.0 (16.2–15.7), 16.3; alveolar length of upper molar series, 8.3, 8.2 (8.5–8.0), 8.3; width of upper molar series, 2.3, 2.3 (2.3–2.25), 2.4.

Comparisons.—From *Neotoma lepida lepida, N. l. sanrafaeli* differs as follows: Size slightly larger. Color: Many specimens inseparable as to color, but in general, *N. l. sanrafaeli* averages more buffy. Skull: Larger in every measurement taken; more ridged and channeled above; brain case more rounded and inflated.

From *N. lepida monstrabilis* the nearest subspecies, geographically and morphologically, *N. l. sanrafaeli* differs as follows: Color: Averages much lighter (lighter ground color), but certain specimens of the light phase of *N. l. monstrabilis* are similar to some specimens of *N. l. sanrafaeli.* Skull: Larger in all measurements taken except breadth of brain case in which they are equal; skull more ridged and channeled in the frontonasal region; palatal bridge markedly longer (all adult ♂♂ specimens of *N. l. sanrafaeli* measure more than 7.1, while none of 8 ♂♂ from northern Arizona and 20 ♂♂ from Utah exceeded 6.9, the averages being 6.7 and 6.6, respectively) upper molar tooth row longer and wider (8.2 by 2.3 as opposed to 7.8 by 2.1).

Remarks.—In his revision of the genus *Neotoma,* Goldman (North Amer. Fauna No. 31: 1–124, 14 figs., 8 pls. Oct. 19, 1910) ascribed a range to *Neotoma desertorum* that included that part of eastern Utah along the west side of the Colorado River below its junction with the Green River and on both sides of the Green River above the junction. That part of the range was largely conjectural since it was based on four specimens from Rangely, Colo., and four from the Henry Mountains (Garfield County?), Utah. Subsequently, the name *Neotoma desertorum* was placed in synonomy with *Neotoma lepida* (see Goldman, Journ. Mamm. **13**(1): 59–67. Feb. 1932). In 1932, Goldman (loc. cit.) named the wood rats from northern Arizona and southern Utah *Neotoma l. monstrabilis*. No mention was made of the animals from Rangely, Colo. In 1942, these were still referred to *N. l. lepida* by Warren (*Mammals of Colorado*). The designation of these animals from northwestern Colorado as *N. l. lepida* is doubtful, since the ranges of *N. l. monstrabilis* and *N. l. sanrafaeli* are interposed between the range of *N. l. lepida* and that area.

Specimens in the collections of the Museum of Zoology, University of Utah, from the vicinity of Escalante, Garfield County, are referable to *N. l. monstrabilis*. Two specimens, nos. 308 and 309, from King's Ranch at the western base of the Henry Mountains in Garfield County, are intergrades between *N. l. monstrabilis* and *N. l. sanrafaeli*. In color they resemble *N. l. monstrabilis;* in the majority of diagnostic cranial characters such as length of palatal bridge, length of nasals, length and width of upper molar tooth row, they are closer to *N. l. sanrafaeli*, to which they are here referred. Thus they represent the southernmost known locality of occurrence of *N. l. sanrafaeli*.

The known range of the subspecies herein described is the same as that ascribed to the kangaroo rat, *Dipodomys ordii sanrafaeli* by Durrant and Setzer (*The distribution and taxonomy of the kangaroo rats* (*genus* Dipodomys) *of Utah*, Bull. Univ. Utah, biol. ser., **9**(3): 1–39, 2 figs., 4 maps. June 30, 1945).

Specimens examined.—Twenty-eight: All from Utah, distributed as follows: *Emery County:* 7 miles north of Green River, 4,100 feet, 2; pump station, 4 miles north of Green River, 4,100 feet, 6; San Rafael River, 15 miles southwest of Green River, 4,200 feet, 6. *Grand County:* Rock Canyon Corral, 5 miles southeast of Valley City; 4,500 feet, 4; 1 mile east of Highway 160, 6 miles south of Valley City, 4,500 feet [= Rock Canyon Corral], 6. *Wayne County:* Notom, 6,200 feet, 2 *Garfield County:* King's Ranch, 5,000 feet, 2.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

431ST MEETING OF BOARD OF MANAGERS

The 431st meeting of the Board of Managers, held in the Cosmos Club on October 17, 1949, was called to order by the President, F. H. H. Roberts, Jr., at 8:10 p.m. Others present were: F. B. Silsbee, H. A. Rehder, Alan Stone, F. G. Brickwedde, W. W. Diehl, F. M. Defandorf, W. N. Fenton, C. L. Gazin, F. E. Johnston, F. D. Rossini, J. B. Reeside, Jr., F. A. Weiss, C. A. Betts, R. S. Dill, A. O. Foster, H. W. Hemple, H. G. Dorsey, O. B. French, F. M. Setzler, and, by invitation, J. L. Shereshefsky.

The President announced that he had appointed John F. Embree to serve as delegate for the Academy at the celebration of the 150th anniversary of the founding of the Connecticut Academy of Arts and Sciences, at Yale University, New Haven, Conn., on November 4, 1949.

The Chairman of the Committee on Grants-in-Aid for Research, J. L. Shereshefsky, indicaten that only one application for a grant had beed received and that he felt that the restrictions controlling the use of the funds available were such that it was difficult for members of the Academy as well as of the constituent societies to qualify. It was suggested that the Chairman confer with officers of the American Association for the Advancement of Science to ascertain whether any changes had been made with regard to these restrictions.

The Committee on Membership submitted the names of two persons for resident membership in the Academy. Nine nominees previously submitted were elected.

The Board announced a request to place John Bright Ferguson on the retired list effective December 31, 1949.

H. A. Rehder reported that a complete set of the Journal and Proceedings of the Academy had been ordered by the library of the Eidg. Technische Hochschule of Zurich, Switzerland. He also reported that 60 copies of Friedmann's monograph *The parasitic cuckoos of Africa* had so far been sold, 12 to persons in foreign countries.

The meeting adjourned at 8:52 p.m.

F. M. Setzler, *Secretary*.

PHILOSOPHICAL SOCIETY

1303d MEETING

The 1303d meeting was held in the auditorium of the Cosmos Club, October 23, 1948, President Ramberg presiding.

Program: K. K. Darrow, Bell Telephone Laboratories: *Magnetic resonance.*—Magnetic resonance is a phenomenon produced by applying, to any of an enormous variety of substances, a steady strong magnetic field and simultaneously a radiofrequency electromagnetic field. By adjusting the ratio of magnetic field strength to frequency of oscillation, it is often possible to detect a strong and sharp absorption limited to a very narrow range of frequencies (if frequency be the variable) or a very narrow range of field strengths (if strength of magnetic field be the variable). Visualizing the ultimate particles of the substance as tiny bar-magnets, which may be inclined at various angles to the steady field, we may conclude that the radiofrequency field turns these magnets from orientations pointed toward the field-direction into orientations pointed away from the field-direction. The absorption represents the work done against the field when these magnets are turned. The particles to which magnetic resonance is due may be electrons or may be nuclei. The experiments enable the observer to determine the magnetic moments of these particles, to study the rate at which thermal equilibrium is established between nuclei on the one hand and between the environing substance and the magnetic field on the other hand, and to investigate various other problems of physics. (*Author's abstract.*)

1304th MEETING

The 1304th meeting was held in the auditorium of the Cosmos Club, November 6, 1948, President Ramberg presiding.

Program: M. C. Shelesnyak, Office of Naval Research: *Human ecology in Arctic regions.*—Increasing interest in the Arctic has revealed an acute absence of any systematic body of scientific information about the basic biological and geophysical conditions. Accumulation and synthesis of systematically collected data are very much needed. Observations during the past century were made chiefly by toil of individuals or small expeditions operating, in general, for short periods with limited technical and financial resources. Many parties have made seasonal studies, but long-term studies are essential to the understanding of Arctic phenomena. Establishment of field stations and laboratories for collection of regional data is vital to Arctic research.

The problems of man in the polar regions are under examination by many and are of special interest to the ecologist, or environmental physiologist. The attention paid these areas, in addition to strategic significance, presents frontiers for investigation of descriptive natural sciences. These regions offer unlimited opportunity for the integration of man's capabilities and limitations with engineering design and development. A continuing concern of man's reactions to the environment and a continuing awareness of the environmental factors confronting them are demanded. (*Author's abstract.*)

1305th MEETING

The 1305th meeting was held in the auditorium of the Cosmos Club, November 20, 1948, President Ramberg presiding.

Program: R. Kronig, Technical University of Delft and Visiting Professor at Johns Hopkins University: *The impedance concept in physics and engineering.*—The concept of impedance introduced in the theory of alternating current circuits and very useful in interpreting the electrical behavior of transmission lines is also applicable to other one-dimensional wave phenomena. Thus, just as in the electrical case, the propagation of plane acoustical, optical, or thermal waves in a homogenous medium and of quantum mechanical waves in a region of constant potential, can be described by a pair of first order linear differential equations of the same type for the two quantities characterizing the wave; the quantities being the pressure and velocity in the acoustical, the two field strengths in the optical, the temperature and heat flow in the thermal, and the wave function and its space derivative in the quantum mechanical problem. Remembering that all these quantities are continuous at the boundary between two media and defining their ratio as the acoustical, optical, thermal, or quantum mechanical impedance respectively, we see that the impedance of a medium, composed of different layers bounded by parallel planes, as well as the reflection factor can be computed by the same formulas that apply to a composite cable in the electrical problem. Applications to wall-covering layers in acoustics and to the surface coating of lenses and mirrors in optics are mentioned, and the use of impedance diagrams in the complex plane are illustrated for these fields. The filter-ing properties of structures periodic in space are mentioned and attention is called to the general relationships between the real and imaginary parts of the propagation constant. (*Author's abstract.*)

1306th MEETING

The 1306th meeting, the 78th annual meeting, was held in the auditorium of the Cosmos Club, December 4, 1948, President RAMBERG presiding.

The report of the Treasurer given by slides showed an income from dues and investments of $1829.45. The current expenses of the Society amounted to $1354.20, leaving a current surplus of $475.25. The current expense per member dropped from $3.75 per member in 1947 to $2.83 per member in 1948. Part of the decrease in expenses during the calendar year was due to the fact that the Joseph Henry Lecturer has not received his honorarium of $100 plus expenses due him when his manuscript is submitted to the Society for publication. The total estimated assets of the Society as of December 1, 1948, were $15,655.67, showing a decrease of $318.75 as compared with December 1, 1947. The Auditing Committee reported that the Treasurer's records and report were in order.

The joint report of the Secretaries showed an active membership of 478.

Program: HORACE M. TRENT, Naval Research Laboratory: *Demonstration of the supersonic reflectoscope.*—Of the many tricks that can be performed with the reflectoscope, the following were selected as being suitable for demonstration to a large audience:

1. THE DETECTION OF FLAWS. The indication obtained from a cylindrical cavity 0.25 by 0.020 inch in a block of aluminum was shown.
2. WAVE GUIDE PROPERTIES OF ULTRASONICS. The indications from two equal-length rods of aluminum, one straight and one S-shaped, were shown.
3. MEASUREMENT OF THIN-PLATE THICKNESS. The series of fish-tail patterns obtained when the operating frequency of the device is varied was demonstrated.
4. INDICATIONS OF INTERNAL DAMPING. The marked difference in the number of multiple echoes obtainable in two rods of armor steel having the same physical dimensions were shown.
5. DYNAMIC CONSTANTS OF PLASTIC MATERIALS. Techniques for establishing the elastic constants of a silicone putty at 1 megacycle/second were demonstrated.
6. ULTRASONICS AS APPLIED TO THE HUMAN BODY. (a) It was shown that human tissue will transmit vibrations of 1 megacycle and that bones are easily located. (b) It was demonstrated that acoustically a gallstone is sufficiently different from tissue to generate a reflection, thus giving promise of a relatively simple method of locating these foreign bodies.

FLOYD A. FIRESTONE, Naval Ordnance Laboratory: *Tricks with the supersonic reflectoscope.*—The supersonic reflectoscope is an instrument normally used for the detection of flaws on the interior of metal parts by sending a short-wave train of ultrasonic waves into the part and then observing the echoes sent back to the sending point. Any echoes arriving at the sending point before the echo from the opposite face of the part are an indication of flaws on the interior.

The waves are sent and received by a thin wafer of quartz placed against the surface of the part with a thin film of oil between. In sending out the waves the quartz is electrically energized with a frequency of about 5,000,000 cycles per second for a time of one-millionth of a second. Reflections of the resulting wave train on striking this same wafer of quartz generate in it a small voltage, which is indicated on a cathode-ray oscilloscope. The sweeping of the oscilloscope spot serves as a time indicating means so that the distance to the reflecting flaw is indicated.

The reflectoscope can be used also for the resonant determination of the thickness of metal parts or for the indication of elastic anisotropy by means of shear waves.

A number of interesting experiments with a reflectoscope supplied by the Naval Research Laboratory were presented by Dr. Horace M. Trent and Mr. Struthers.

1307th MEETING

The 1307th meeting was held in the auditorium of the Cosmos Club, December 18, 1948, President JOHNSTON presiding.

Program: F. D. MURNAGHAN, Johns Hopkins University: *The evolution of the number concept.*—The evolution of the number concept was developed all the way from the counting stage up to and including the quaternion. The intermediate stages discussed were the relative number, the slope number, the real number, and the complex number. The larger part of the paper was devoted to the discussion of the simpler number properties usually regarded as obvious. A negative number was represented as a relative number or linear one dimensional vector, and the procedure for adding and multiplying such relative numbers was discussd. A method of multiplying numbers was presented that makes it unnecessary to learn multiplication tables beyond the number 5. The subject of fractions was approached from the viewpoint of the slope number concept, and fundamental operations involving such numbers were developed. The more advanced number concepts, such as the complex number and quaternion, were touched on very briefly.

1308th MEETING

The 1308th meeting was held in the auditorium of the Cosmos Club, January 15, 1949, President JOHNSTON presiding.

The retiring president, WALTER RAMBERG, National Bureau of Standards, delivered his presidential address on the subject *Contributions of electricity to mechanics.* This address was published in this JOURNAL **39** (9): 281–294. 1949.

1309th MEETING

The 1309th meeting was held in the auditorium of the Cosmos Club, January 29, 1949, Vice President KRACEK presiding.

Program: HAROLD LYONS, National Bureau of Standards: *Frequency and time standards and the atomic clock.*—The present standard of time is the mean solar day, which is slowly growing longer and fluctuates by about 1 part in 25 million. These and other limitations in astronomical standards make it desirable to look for new invariant and reproducible standards of time and frequency such as those using spectrum lines.

The first atomic clock using the inversion spectrum of ammonia was designed to put frequency and time standards on an invariant basis. It is of the servo type in which a quartz-crystal clock is regulated by the ammonia absorption line through a frequency multiplier chain. Tests showed a constancy of better than 1 part in 20 million.

Three other proposed clocks were described. These consist of two absorption-line or atomic oscillators driving clocks through frequency dividers. The third is a servo clock using atomic beam techniques with a potential accuracy of 1 part in 10 billion. The atomic oscillators are of the feedback type in which regenerative feedback to a microwave amplifier is controlled by an absorption cell. One such oscillator transmits the feedback signal through a magic-tee in which the cell terminates one impedance arm. The other uses a 6-arm wave-guide Wheatstone bridge to control feedback. (*Author's abstract.*)

An informal communication was presented by HARVEY CURTIS, of the National Bureau of Standards, entitled *An annual meeting of forty years ago.* Annual meetings in those days were dress affairs. The attendance in general was much smaller (about 20), and the meetings were held in the east end of the main lounge of the Cosmos Club in probably the same chairs that are now there. Cigars were provided for all members by the Society, and the annual meeting was the only meeting during the year at which refreshments were served. The president of the Society at that time was Simon Newcomb, the eminent astronomer. The officers of the Society were elected by ballot and frequently more than one ballot was necessary. About half the membership served on the General Committee, which handled the business affairs of the Society. (*Secretary's abstract.*)

1310th MEETING

The 1310th meeting was held in the auditorium of the Cosmos Club, February 12, 1949, Vice President KRACEK presiding.

Program: J. R. DUNNING, Columbia University: *High-energy accelerator progress.*—High-energy accelerators should play a steadily more important role in studying nuclear processes, nuclear forces, and the nature of "fundamental" particles. Progress in the design of accelerators was discussed for electrostatic generators, conventional cyclotrons, synchrocyclotrons, linear accelerators, betatrons, electron synchrotrons, and proton synchrotrons. The limitations of the various types were pointed out, and it was concluded that whereas the synchrocyclotron and electron synchrotron are satisfactory in the 500 MEV to possibly 1 BEV region, the proton synchrotron appears most practical in the 1 to 10 BEV region. The possibilities of future research with these nuclear machines were discussed. (*Author's abstract.*)

1311th MEETING

The 1311th meeting was held in the auditorium of the Cosmos Club, February 26, 1949, Vice President CHENEY presiding.

Program: L. MARTON, National Bureau of Standards: *Observations of electromagnetic fields.*—For many years a very convenient method, called the Schlieren method, has been widely used in light optics for the purpose of observing small changes in the refractive index of more or less homogeneous media. Such a method can be easily translated in terms of electron optics by using electron beams instead of light rays and the variations of the electromagnetic index of refraction instead of that of the index for light. The consequences are that by means of a systematic application of this well-known method to electron optics we are able to measure electromagnetic fields that may otherwise be partially or even completely inaccessible to any other type of measurement.

The simplest application of this new electron optical method consists of producing a reduced-size image of an electron source by means of a magnetic or electrostatic electron lens and of catching all direct rays by a suitably placed stop. If there are no fields of force between the source and the lens, the space beyond the stop will be completely dark. If, however, there is a variation of the electromagnetic index of refraction somewhere between the source and the lens, in a conjugate plan to such a disturbance, a dark field image will appear.

The essential features of the new method have been demonstrated and examined by using a magnetized steel wire (as used for recording purposes) as a convenient test object. The patterns obtained can be compared readily to colloidal powder patterns obtained on the same material. They show that, in a qualitative manner, the agreement is excellent. For quantitative purposes, however, the dark field method is not quite satisfactory, and that is why a bright field method, more suitable for quantitative investigations, has been developed. This bright field method consists in its simplest form of an electron source and an electron lens forming a reduced sized image of the source. At a convenient distance behind the image of the source a fine wire mesh is placed. The image of the source, acting as a virtual source of very small size, produces an enlarged shadow image of the wire mesh in the image plane. In the absence of any fields in the object space the image of the mesh is undistorted. In the presence of fields, however, the picture of the mesh will be distorted and the amount of distortion is a measure of the strength of these fields. Experiments, carried out mostly on the same magnetized-wire material as mentioned before, have shown that the method is eminently suited to quantitative investigation.

This new method for mapping of electromagnetic fields can be applied to a very wide variety of phenomena, such as space charge fields, fields of standing electromagnetic waves, and fields resulting from contact potentials. As a demonstration of the usefulness of this method slides depicting fields of individual ferromagnetic domains were shown. (*Author's abstract.*)

1312th MEETING

The 1312th meeting was held in the auditorium of the Cosmos Club, March 12, 1949, Vice President KRACEK presiding.

Program: E. TELLER, University of Chicago: *The origin of cosmic rays.*—The presence of heavy particles in cosmic rays makes it plausible that cosmic radiation is generated by the acceleration of charged particles in extended electromagnetic fields. The energy density of cosmic rays ($3 \times 10^{-10}\ Mc^2/cm^3$) would lead to very great total amounts of energy if one assumes that cosmic radiation extends throughout intergalactic or throughout interstellar space. This would require very efficient methods of cosmic ray production. Fermi has recently proposed a most ingenious mechanism that may furnish the required energy to the cosmic radiation. According to this proposal, cosmic radiation constitutes an essential component in the energy distribution within the galaxy, and the mechanism regulating the intensity of cosmic rays is based upon the balancing of the various forms of energy. Difficulties connected with the presence in cosmic radiation of nuclei carrying more than one charge give rise to some doubt whether or not Fermi's proposal is the correct explanation of cosmic rays. It is therefore of interest to investigate the possibility that cosmic rays are generated in the vicinity of the sun and are confined to the solar system by extended magnetic fields. The strength of these fields is estimated to be 10^{-5} Gauss. According to this picture, cosmic rays circulate in the neighborhood of the planetary system for thousands of years during which time the radiation becomes isotropic. The electron component of the radiation is eliminated by collisions with solar light quanta. (*Author's abstract.*)

1313th MEETING

The 1313th meeting was held in the auditorium of the Cosmos Club, March 26, 1949, President JOHNSTON presiding.

Program: H. F. STIMSON, National Bureau of Standards: *The international temperature scale.*—

The platinum resistance thermometer was developed during the last part of the nineteenth century and the beginning of the twentieth. With resistance thermometers it became possible to determine temperatures more precisely than with a gas thermometer. The experimental difficulties inherent in the measurement of temperature on the thermodynamic scale led to the adoption, in 1927, of a practical scale which was designated as the international temperature scale. Provisions were made for revising this scale, but it was not until 1948 that a revision was adopted.

The international temperature scale of 1948 is based upon six fixed and reproducible equilibrium temperatures to which numerical values have been assigned and upon specified interpolation formulas relating temperature to the indications of specified measuring instruments. It is designed to conform as nearly as practicable to the thermodynamic Celsius (centigrade) scale as now known, while incorporating certain refinements based on experience to make the scale more uniform and reproducible than its predecessor. A new value for the temperature of the silver point and the use of Planck's law with a new value for the radiation constant c_2 are the only changes which produce significant effects on numerical values assigned to temperatures. (*Author's abstract.*)

1314th MEETING

The 1314th meeting was held in the auditorium of the Cosmos Club, April 9, 1949, President JOHNSTON presiding.

Program: JOHN A. WHEELER, Princeton University: *Mesons, the elusive elementary particles.*—The study of the nuclear transformations produced in the upper atmosphere by the high-energy hydrogen nuclei incident upon the earth from outer space has been and continues to be a fruitful means to learn about the properties and genetic interrelations of the elementary particles. That three-fourths of the cosmic radiation arriving at sea level is made up of mesons was discovered by Carl Anderson in 1938. These particles have a mass approximately 214 times the mass of the electron, or about one-ninth the mass of a proton. In 1947 Powell and his collaborators at Bristol discovered another heavier meson of mass now believed to be approximately 286 times the mass of the electron, a particle with life only 10^{-8} sec, which serves as the progenitor of the ordinary sea-level variety of meson. How both kinds of mesons disappear via radioactive decay or nuclear reactions was described. From analysis of these transformations it has turned out that there exists a remarkable and so far unexplained regularity—an approximate identity in the values of the so-called coupling constants required to account for (a) the radioactive decay of the sea-level kind of meson into an electron and two neutral particles, presumably neutrinos; (b) the radioactive decay of a nuclear neutron into a proton, an electron and a neutrino, and (c) the reaction of a sea-level meson with a nuclear proton to form a neutron and a nuclear particle, presumably a neutrino. Finally a summary was made of the experimental evidence recently obtained by Dr. W. Y. Chang, of Princeton, for the emission of characteristic gamma radiation with energies in a range 1, to 4 Mev by mesons jumping from one Bohr orbit to another in a field of force of an atomic nucleus. (*Author's abstract.*)

1315th MEETING

The 1315th meeting was held in the auditorium of the Cosmos Club, April 23, 1949, PRESIDENT JOHNSTON presiding.

Program: BRUNO ROSSI, Massachusetts Institute of Technology: *Cosmic rays.*—Cosmic rays are of great interest both to the astronomer and to the physicist. From the point of view of the physicist, cosmic rays may be regarded as a source of very high energy particles. Cosmic rays contain all kinds of known elementary particles, some of which were actually discovered during the study of cosmic ray phenomena. Elementary particles interact with matter through forces of electromagnetic character and of nuclear character. The general laws of quantum electrodynamics appear adequate to describe electromagnetic interactions. No general theory of nuclear interactions exists so far. Experiments have shown that nuclear interactions in cosmic ray phenomena are mainly due to high energy protons and neutrons. They have also shown that nuclear interactions give rise to secondary nucleons as well as to mesons and to electronic radiation. Much more experimental work is necessary before all the details of nuclear interactions of high energy particles are completely understood. What has been learned so far, however, is sufficient to clarify the relationship between the primary cosmic radiation, believed to consist mainly of high energy protons, and the radiation observed under thick layers of air, which is known to consist mainly of mesons and electrons. (*Author's abstract.*)

1316th MEETING

The 1316th meeting was held in the auditorium of the Cosmos Club, May 7, 1949, President Johnston presiding.

Program: Henry Margenau, Yale University: *Causality in classical and modern physics.*—Common speech uses the words "cause and effect" in the sense of partial cause and partial effect. As such they may mean things or events. History has progressed toward a more refined definition of these terms; in this refined version they mean states of certain systems.

Upon discussion and analysis, LaPlace's classical formulation of the causal principle was found defective, requiring supplementation in the form of restrictions upon his world formula. It was shown that this formula may not contain the time variable explicitly. Consideration of the changes that have taken place in the description of states as a result of quantum mechanics leads to the conclusion that modern physics is still a causal discipline, provided the states of its systems are correctly defined. In conclusion, recent attempts to demonstrate human freedom on the basis of quantum mechanics were viewed and were shown to be unsuccessful. (*Author's abstract.*)

1317th MEETING

The 1317th meeting was the occasion of the Eighteenth Joseph Henry Lecture and was held in the auditorium of the Cosmos Club, May 14, 1949, President Johnston presiding.

Program: Maurice Ewing, Columbia University: *Basement rocks beneath the ocean.* This address will be published in full in this Journal.

1318th MEETING

The 1318th meeting was held in the auditorium of the Cosmos Club, May 21, 1949, President Johnston presiding.

Program: R. J. Seeger, Naval Ordnance Laboratory: *On research in aerophysics.*—Throughout the history of science fluid dynamics has been concerned largely with ideal fluids with or without viscosity. In recent years it has been primarily a domain of mathematics, which has concerned itself with solving the basic partial differential equations for particular boundary conditions. Physical phenomena such as turbulence have long been regarded as incomprehensible. Nowadays, however, as faster and faster aircraft have come into existence, neglected physical factors such as compressibility (including shock-wave phenomena with its attenuating shock waves, their interactions with boundary layers, and the associated thermal conduction) have presented experiential questions that can no longer be ignored. Moreover, the achievement of high altitudes with their peculiar problems of rarefied gases has invoked renewed interest in kinetic theory both for equilibrium and nonequilibrium states. The term aerophysics has been applied in recent years to this area of investigation.

The meaning of high-speed flow in this connection is one of relative speed rather than of absolute speed. Thus the maximum speed attainable for expansion under atmospheric condition is 2,770 ft/sec, whereas the Mach number in this case could potentially become infinite (assuming no change in the extrapolated physical equation state). The speaker's remarks concerned the aeroballistic research facilities at White Oak, Md., which are prosecuting a vigorous program involving such high-speed flows. A discussion of the facilities included the two 40 by 40 cm supersonic wind tunnels and the 18 by 18 cm spersonic wind tunnel, which are now operating up to Mach numbers of 5. In addition, four 12 by 12 cm supersonic wind tunnels, which are now being constructed, were described; namely, one for internal aerodynamics, one for aerophysics, one for heat-transfer, and one for hypersonics.

A historical example emphasized the difficulty of correlating scaled wind-tunnel data with free-flight experiments involving unknown phenomena such as turbulence. Information was given about the NOL pressurized ballistics range, which will permit investigations of Reynolds' number effects under variable pressure.

Finally, the shock tube was cited as an auxiliary aeroballistics apparatus that can be utilized for precision experiments on non-linear phenomena. For example, a study of the refraction of gaseous shock waves presents challenging predictions for experiential observations: namely, (1) the limit of regular refraction to certain angles of incidence beyond which new phenomena must appear, (2) the nonexistence of critical reflection for finite shock waves, and (3) the existence of either reflected shock waves or of reflected rare faction waves from the boundary of two gaseous media, depending upon the strength and the direction of the incident wave (hence the possibility of a transition angle at which no reflected wave at all exists). (*Author's abstract.*)

R. Smelt, Naval Ordnance Laboratory: *Problems of hypersonic flow.*—The aerodynamicist realizes that outside the range of his present equipment to study supersoic flow there are other regimes of flow which are currently described as "hypersonic." The term hypersonic is rather indefinite, for it covers a large number of distinct phenomena. For example, one definition of hypersonic flow describes it as flow at Mach numbers exceeding those where simple linearized supersonic theory is applicable. This can be shown to be related to pressure conditions approaching absolute vacuum at some point in the flow.

Other phenomena that become apparent at very high speeds result from the fact that air is an imperfect gas. To some extent the adoption of a new equation of state can describe these effects.

Experimental methods of achieving hypersonic flow conditions include the hypersonic wind tunnel, expanding air from a high pressure into a vacuum, and the hypersonic range, in which projectiles are fired through still air at very high speeds. Problems of the hypersonic tunnel result from the approach to liquefaction temperatures in the air after expansion. The hypersonic range, on the other hand, produces problems of dissociation and even ionization in consequence of the high air temperatures produced around a projectile. (*Author's abstract.*)

Archie I. Mahan, *Recording Secretary.*

Obituary

Raymond McGeary Hann, chief of the laboratory of chemistry at the National Institutes of Health, died early in the morning of April 30, 1949, at the U. S. Marine Hospital in Baltimore, Md., and was buried at the Arlington National Cemetery. His death was caused by a malignant growth in the pharynx which had bothered him since 1944. During these last five years, in spite of the fact that his health was growing progressively worse, his spirits remained high and he continued with his research and writing.

Dr. Hann was born in Washington, D. C., on January 28, 1900. After graduation from high school in 1918 he entered the United States Army, but after two months of service the war was over, and he was given his release. He then started work as a scientific aide at the U. S. Department of Agriculture and at the same time entered the George Washington University evening school to study chemistry. In 1925 he received his B.S. degree. His research work with the Department of Agriculture while attending school gave him 15 scientific publications before he received this degree. In 1926 he received his M.S. degree from the same institution. In 1928 he received his Ph.D. degree in chemistry from the Johns Hopkins University in Baltimore.

The following year after graduation he held a fellowship at the Mellon Institute for Industrial Research in Pittsburgh. He then entered the National Institute of Health as a research chemist, specializing in the organic chemistry and synthesis of sugars. During his 20 years at this institution he published more than 120 research papers, most of which are published in the Journal of the American Chemical Society.

He joined the American Chemical Society in 1922 and was very active in the Washington local section, being its treasurer in 1936 and 1937, its secretary in 1938 and 1939, and its president in 1940. He was a Vice President of the Washington Academy of Sciences in 1940. He was also an active member of the Alpha Chi Sigma Professional Chemical Fraternity.

In 1944 the Chemical Society of Washington presented him with the Hillebrand Award, which is given annually to a Washington member for noteworthy contribution to chemistry. Dr. Hann's award was based on his work in sugar chemistry, "investigations leading to a number of anhydro sugars culminating in the definitive synthesis of lactose and cellobiose; and the application of copper sulfate oxidation of sugar phenylosazones to form osatriazoles, compounds which promise to find wide use in the characterization of sugars."

At the request of the division of sugar chemistry and technology of the American Chemical Society, he and a collaborator collected and edited for publication all the works of Dr. C. S. Hudson, which appeared in two volumes in 1948.

Dr. Hann's chief hobby was boating, which he took very seriously. Before the last war he was the owner of a 34-foot cabin cruiser, on which he and his friends spent many delightful hours. He was a member of the Corinthian Yacht Club. He was also a member of the Potomac River Power Squadron, a boating organization, in which he was very active, especially in the studying and teaching of seamanship, piloting, and celestial navigation.

Dr. Hann was married in 1931 to Miss Rhonda Nebeker. They had one daughter, Carol, who was eight years of age at the time of her father's death.

Norman Bekkedahl.

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JOURNAL
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ARCHEOLOGY.—*A unique archeological specimen from Australia.*[1] FRANK M. SETZLER, U. S. National Museum, and FREDERICK D. McCARTHY, Australian Museum, Sydney.

On October 26 and 27, 1948, within a few days prior to the closing of the Arnhem Land Expedition camp[2] at Oenpelli, we had the good fortune to recover the hafted adz and blade described and illustrated here (Fig. 3). Since these constitute type specimens, it is considered advisable to publish this preliminary description. Oenpelli is located on the western edge of the Arnhem Land Aboriginal Reserve in northern Australia (see map, Fig. 1). The specimens were discovered in a rock shelter, site 2, on Oenpelli Hill (Argaluk) during excavations that constituted a part of the anthropological investigations undertaken by the authors as members of the Arnhem Land Expedition. The excavations of the two rock shelters at the highest point on Oenpelli Hill were under the supervision of the senior author. The type of chipped blade, attached to the wooden handle by means of the hardened ironwood gum, is typical of the many quartzite blades found in most of the 12 rock shelters we excavated on Gallery (Inyalark) and Oenpelli Hills in 1948.

The *elouera* adz-flake had not previously been recorded from Arnhem Land. It has been recorded from Hook Island and Point Cartwright, along the Queensland coast, and occurs occasionally but not as a dominant specialized type in the Pirrian, Mudukian, and Murundian surface sites in far western New South Wales and other parts of the interior of the continent, but is not known in Victoria. It has been recorded on surface sites belonging to the Bondaian culture in the Woakwine Ranges of South Australia (Campbell and Noone, 1943, p. 382, figs. 111–112). One was found in layer IV of the Murundian culture in the Devon Downs rock shelter (Hale and Tindale, 1930). It occurs as a dominant specialized knapped implement in eastern New South Wales on coastal shell-middens, in rock-shelter deposits, and on surface sites from the coast to the tablelands on the western side of the Great Dividing Range (McCarthy, 1943, south coast, pp. 139–140, figs. 17–19, Bathurst, p. 204, fig. 23; McCarthy and Davidson, 1943, Singleton, p. 217, figs. 13–16, 19; McCarthy, Bramell, and Noone, 1946, pp. 27–28, figs. 82–87). The *elouera* adz-flake occurs in both the Bondaian and Eloueran cultures revealed by the Lapstone Creek excavation in the Blue Mountains and is more abundant in the latter and younger culture (McCarthy, 1948).

Up to the time of our discovery it was uncertain as to the use to which these quartzite blades had been put by the Australian aborigines. A great deal of controversy has centered about the way in which the *elouera* was used (the references to which are given by McCarthy, Bramell, and Noone, op. cit.). Some students asserted that it was a chipped-back knife, the thin edge of the chord being used as a knife and the thick, crescentic back shaped for holding in the fingers. Others claimed that its chief function was that of a scraper along its thick margin. McCarthy has always held the opinion that the *elouera* is an adz-flake (McCarthy, Bramell, and Noone, op. cit.,

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[1] Received October 3, 1949. Published by permission of the Secretary of the Smithsonian Institution.

[2] Commonwealth of Australia–National Geographic Society–Smithsonian Institution Expedition to Arnhem Land.

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p. 29; McCarthy, 1948, p. 31). Noone (1943) recorded six *elouera*-like hafted adz-flakes in the Western Australian Museum's collection. The specimen herein described from Oenpelli is conclusive evidence, as revealed by the X-ray (Fig. 2), that the *elouera* was used as an adz-flake in those parts of Australia in which it occurs as a dominant specialized knapped implement.

The importance of the hafted shell or trimmed stone flake adz as a working tool of the Australian aborigines has long been recognized by Australian archeologists. The stone flake and blade adzes, which are hafted, vary considerably in shape (McCarthy, Bramell, and Noone, 1946, pp. 27–30, figs. 104–109, 324–325, bibliography). Most of them are hafted at the end of a spear-thrower or a rounded wooden, sometimes a bone, handle. The adz-flake is set in a gum cement, the nature of which varies in different localities. However, the working edge of the adz-flake, in the majority of cases, projects transversely, that is, across the end of the handle, but on the specimen from Oenpelli it is mounted laterally (Fig. 3).

The X-ray[3] reveals that the red quartzite adz-flake is of the *elouera* type, with a comparatively straight back or thick lateral margin; it has oblique ends, and the working edge is convex and irregular. This *elouera* adz-flake measures 3.5 cm long, 2.5 cm wide, and 1 cm on the thick margin. The cutting edge projects 1.2 cm from the gum cement. The working edge is not trimmed or retouched but bears use-polish on both facets; this polish is concentrated chiefly on the rounded portion in the middle of the working edge on one side of the flake, but it extends along the other side and is up to 2 mm wide in the middle. The gum cement measures 6 by 5 by 2.5 cm; it is a rounded mass shaped from the thick butt side, which encloses the top of the wooden handle and over half the width of the adz-flake. The X-ray reveals that the thick back of the adz-flake is not set against the wood but is separated by gum almost 1 cm wide from the handle, and that the top of the handle

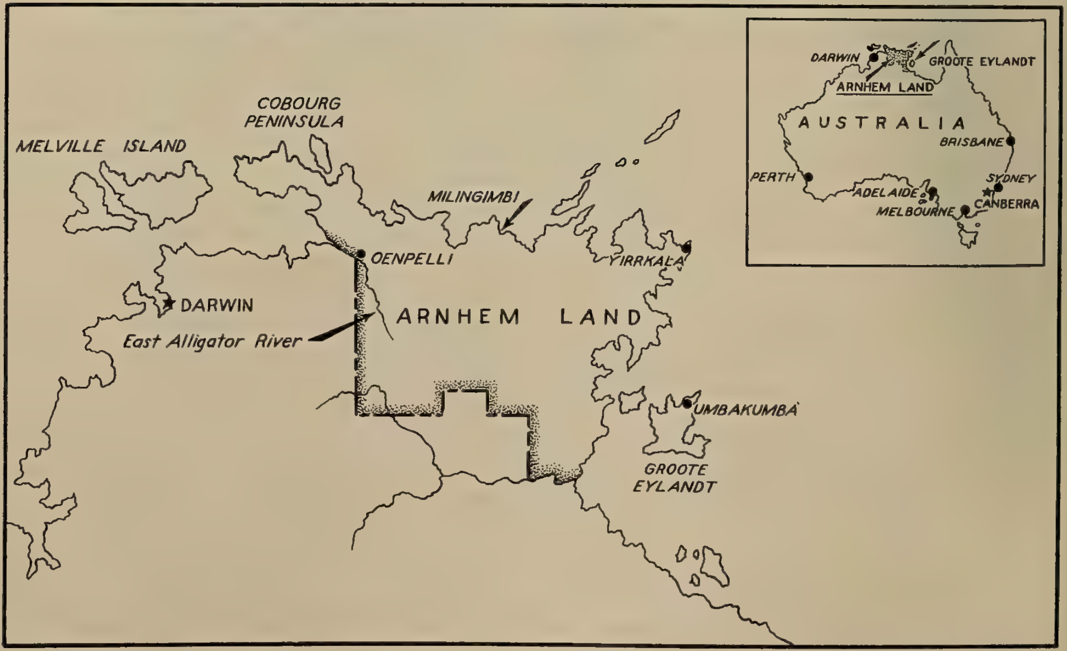

FIG. 1.—Map showing location of Oenpelli on the western edge of Arnhem Land, Northern Australia.

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[3] Kindly made by Drs. J. L. and K. E. Shellshear, of Sydney.

is barely covered with gum. The handle is a roughly shaped strip of ironwood (*Erythrophloeum chlorostachyus* or *E. laboucherii*); it is flattened on both sides and tapers to a point at the grip end. It is 35 cm long, 3 cm wide, and just over 1 cm thick in some parts and is almost black on one side and light brown on the other. There is a shallow

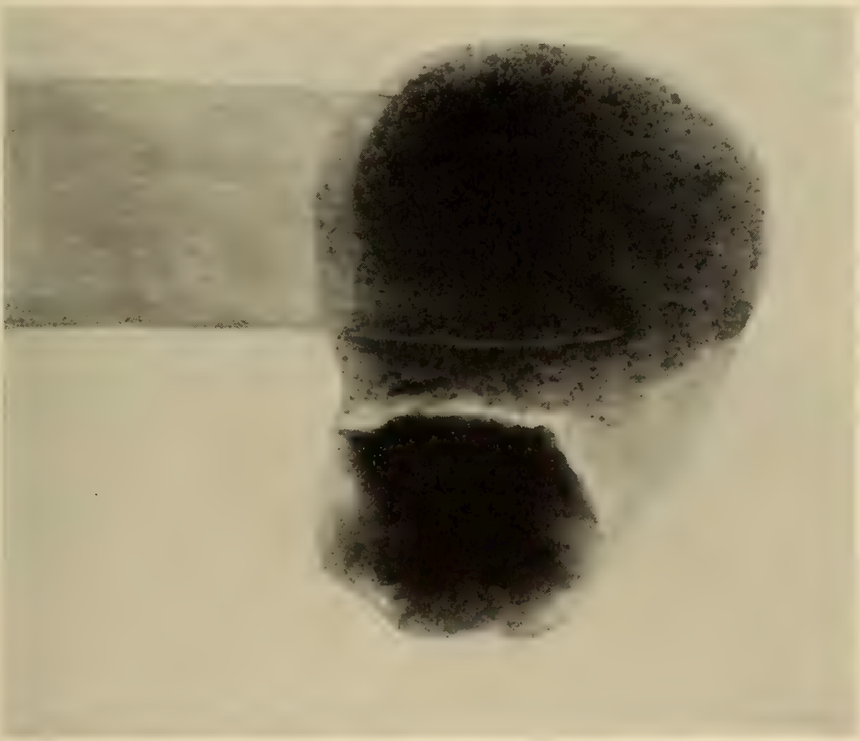

FIG. 2.—X-ray photograph of hafted adz showing the chipped quartzite adz-flake similar to those illustrated in Fig. 3.

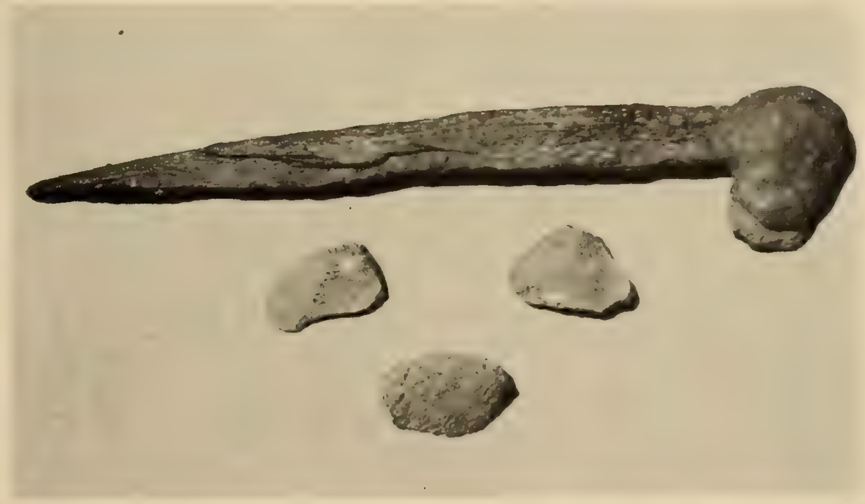

FIG. 3.—The hafted adz and *elouera* flake; also three types of chipped quartzite blades excavated in cave no. 2, on Oenpelli Hill (Argaluk). Length of adz 13½ inches (35 cm); width 1¼ inches (3 cm); thickness, 3/8 inch (1 cm).

depression 6 cm long in the middle of the inner edge, which forms a convenient grip. All the ridges on the dark side of this handle are polished as though from the holding of the tool during use, particularly from the middle to the pointed end, and along the concave area, but this polish is barely perceptible on the other side. The gum cement is obtained by heating the roots of the ironwood tree.

The *elouera* proved to be a dominant specialized type of knapped implement in the Oenpelli rock shelters that we excavated, and many of the *elouera* recovered bear a pronounced use-polished working edge or sheen on the chord. Most of them are made of red quartzite, and they are identical in form and dimensions with the eastern New South Wales *elouera* made out of a variety of cherts, jasper, quartzite, chalcedony, silicified wood, and other materials. The use-polished edge occurs on *elouera* in the latter locality (McCarthy, 1943, south coast, pp. 132, 145, Bathurst, p. 207; 1948, pp. 7, 15) but not so commonly as at Oenpelli and on the large *worimi* hand cleavers (McCarthy, 1947, pp. 420, 423, 426, figs. 8, 11) from the north coast of New South Wales. Thus another important aspect of the discovery of this hafted adz at Oenpelli is that its adz-flake, an *elouera*, has a use-polished edge, a kind of working edge to which attention has only previously been drawn by the above author.

A second red quartzite blade from site 2 on Oenpelli Hill bears a use-polished edge. This blade is 4 cm long, 3.5 cm wide, and 3.5 mm thick, although at one end, broken transversely, it is only 2 mm thick. This thin blade had also been hafted, since it bears a layer of gum cement on one side which is 6 mm thick, and the area that had been covered by the gum is clean and well defined from the discolored area exposed. The sheen is on one side only of the working edge and is up to 2 mm wide.

The use made of the hafted adz and the explanation of the use-polished edge, which appears also as a diagnostic trait on many other flakes and blades at Oenpelli, are problems that must remain within the realm of theory. Local natives, even the old men, were unable to give any specific uses, and most of them suggested that it was a woodworking tool. A suggestion advanced by one of the native workmen on the excavation was that it could have been used for enlarging the hole made in a tree to cut out a bees' nest and to scrape out the comb and honey. Other possible uses that would produce a use-polished edge are the dressing of skins, cleaning off outer bark, and smoothing off the surfaces of wooden shields, clubs, spear-throwers, and sacred objects. That the usage was of some variety is indicated by the occurrence of this type of working edge on implements ranging from thin flakes to hand cleavers, and on hafted adzes.

The hafted adz from Oenpelli weighs only 5 ounces and would not be a burden for these nomadic hunters and fishermen to carry about. Like many other aboriginal implements, it probably served a number of purposes.

No other hafted adz has been recorded from Arnhem Land, where the use of stone implements began to wane when the Makassan trepangers introduced metal tomahawks and knives some centuries ago, to be followed by the white man early in the nineteenth century. Sir Baldwin Spencer (1914), who made a large collection of ethnological specimens at Oenpelli and neighboring areas in 1912; Basedow (1907), who described the material culture of the west coast; Tindale (1922), who described the material culture of Groote Eylandt; and Warner (1937), who dealt with the Milingimbi area, do not mention this implement.

The original specimens described are deposited in the Australian Museum in Sydney. Casts will be sent to the Smithsonian Institution.

Our field work in Arnhem Land resulted in the establishment of three cultures:

PIRRIAN: *Pirri* uniface points, and scrapers, found on a surface site at Yirrkala.

MILINGIMBIAN: Edge-ground biface axes (some of which are highly polished from the blade to the middle of the ax), *Riambi* oyster picks, hammerstones and hammer-anvil stones, pestles and mortars, red and yellow pigments, associated with an unconventionalized flake industry in which there are *no* points. From the large shell midden known as the Macassar Well site on Milingimbi Island.

OENPELLIAN: Uniface (*Pirri*) points and biface points, *elouera* adz-flake as the dominant flake type, a variety of scrapers (many of microlithic size but none of geometrical type present), *Leilira* quartzite blades, flake-fabricated hammerstones, red and yellow pigments, bone *muduk* points, pestle and mortars; *elouera*, flake and blades with use-polished working edge. Associated with top deposit and bundle burials, modern iron nails and implements, twined and netted bag fragments, wooden weapons, trade beads.

This note serves only as a general description of an important archeological discovery in Arnhem Land. The authors are preparing detailed reports of their anthropological investigations during the eight months of field work in this northern section of Australia. This international expedition, led by the Australian representative C. P. Mountford, was made possible through the joint sponsorship of the Commonwealth of Australia, the National Geographic Society, and the Smithsonian Institution.

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PALEONTOLOGY.—*North American Jurassic Foraminifera, II: Characteristic western interior Callovian species.*[1]

ALFRED R. LOEBLICH, JR., U. S. National Museum, and HELEN TAPPAN, U. S. Geological Survey.

Callovian (basal Upper Jurassic) beds contain rich and well-preserved foraminiferal assemblages in many parts of the western interior of the United States and Canada. In the eastern area of exposures around the Black Hills of South Dakota and Wyoming the medial part of the Lower Callovian consists in large part of sandy siltstone that contains abundant Ostracoda and sparsely developed foraminiferal assemblages dominated by simple lagenids and arenaceous Foraminifera. Toward the west in Wyoming and Montana the Callovian strata become more calcareous, and Foraminifera dominate the microfossil assemblages. The foraminiferal assemblages are also more diversified to the west and are characterized by a great variety of lagenids and lituolids.

The writers have in preparation a monographic treatment of the western interior Jurassic Foraminifera but are here recording a few of the more characteristic species, so that they may be of use in stratigraphic work now in progress in the area. The field work was undertaken as a project of the U. S. Geological Survey, and the writers are indebted to Dr. Ralph W. Imlay for his valuable assistance in the field and to Dr.

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[1] Published by permission of the Secretary of the Smithsonian Institution and the Director of the U. S. Geological Survey. Received September 26, 1949.

John B. Reeside, Jr., for his interest and aid in making possible the field study and collection of material.

DESCRIPTION OF LOCALITIES

Locality 1.—Ellis group. At the southwest corner of Red Dome, east of Bridger, in the Pryor Mountains, sec. 19, T.7S., R.24E., Carbon County, Montana. Collected September 13, 1948, by Ralph W. Imlay and Alfred R. Loeblich, Jr. A complete section of the Ellis Group (Piper, Rierdon and Swift formations) is well exposed at this locality.

Locality 2.—Ellis group. One mile southwest of Piper on the northwest corner of the escarpment due east of Bacon Ranch, sec. 17, T.14N., R.20E., Fergus County, Montana. Collected September 14, 1948, by Ralph W. Imlay and Alfred R. Loeblich, Jr. This locality includes the type section of the Piper formation, an excellent exposure of the Rierdon formation, and the basal portion of the Swift formation.

Locality 3.—Sundance formation. On the west side of Stockade Beaver Creek, 5 miles northeast of Newcastle, sec. 18, T.45N., R.60W., Weston County, Wyoming. Collected September 21, 1948, by Ralph W. Imlay and Alfred R. Loeblich, Jr. This locality is the type section of the Stockade Beaver shale member, and in addition, the Hulett sandstone member, the Lak member, and the basal part of the Redwater shale member of the Sundance are well shown.

Locality 4.—Sundance formation. Along the east side of Red Gulch, about 2½ miles south of little Big Horn River in sec. 22, T.58N., R.89W., Sheridan County, Wyoming. Collected by R. W. Imlay and A. R. Loeblich, Jr., September 23, 1948. This locality affords excellent exposures of the Stockade Beaver shale member, Hulett sandstone member, and Redwater shale member of the Sundance.

Locality 5.—In the gorge of the Shoshone River, 1¼ miles west of Cody, Park County, Wyoming. Collected September 19, 1948, by Ralph W. Imlay and Alfred R. Loeblich, Jr. This locality exposes in detail the entire marine Jurassic sequence found in this area.

Locality 6.—Sundance formation. On the east side of Elk Mountain, about 15 miles southeast of Newcastle, Wyoming, in the S½ sec. 19, T.4S., R.1E., South Dakota. Collected September 22, 1948, by Ralph W. Imlay and A. R. Loeblich, Jr. This locality is an excellent one for the lower portion of the Stockade Beaver shale member.

Locality 7.—Sundance formation. In the J. H. Kline Well no. 1, 3½ miles southeast of Carpio, Ward County, North Dakota.

DESCRIPTION OF FORAMINIFERA

Family AMMODISCIDAE

Subfamily AMMODISCINAE

Genus **Ammodiscus** Reuss, 1861

Ammodiscus cheradospirus Loeblich and Tappan, n. sp.

Pl. 1, figs. 1–2b

Test free, medium-sized, discoidal, somewhat irregularly planispirally coiled, periphery rounded with margins irregular; proloculum, in holotype 0.08 mm in diameter, circular, tubular second chamber increasing gradually in size, only occasionally overlapping the preceding coil; spiral suture distinct, depressed; wall very finely arenaceous, with much cement, insoluble in acid; aperture formed by the open end of the tubular chamber.

Maximum diameter of holotype 0.68 mm, diameter of figured paratype 0.44 mm, maximum thickness 0.10 mm. Other specimens vary in diameter from 0.55 mm to 1.53 mm.

Types and occurrence.—Holotype (U.S.N.M. no. 106014) and figured paratype (U.S.N.M. no. 106015) and unfigured paratypes (U.S.N.M. no. 106016) from the Rierdon formation, 33 feet above the base, at locality 1. Specimens are common in this level of the Rierdon formation at this locality.

Remarks.—This species differs from *Ammodiscus gaultinus* Berthelin from the Lower Cretaceous of France in being more regularly planispiral and in being somewhat larger in size.

Family LITUOLIDAE

Subfamily HAPLOPHRAGMIINAE

Genus **Frankeina** Cushman and Alexander, 1929

Frankeina commutata Loeblich and Tappan, n. sp.

Pl. 1, figs. 3a–4

Frankeina sp.? Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27:** 158, pl. 1, fig. 2. 1933.

Test free, medium-sized, elongate, compressed and planispiral in the early part, later uniserial and triangular in section, periphery rounded; planispiral chambers strongly compressed, comprising a relatively large portion of the test, about one and two-thirds volutions in the coil;

later portion uniserial, chambers increasing slowly in diameter, in the holotype the final chamber being less in diameter than the early coil, sides moderately excavated; sutures generally indistinct, in the coiled part straight or with a very slight backward curve, very slightly depressed in the uniserial portion, but generally indistinct except at peripheral angles; wall medium to coarsely arenaceous, surface roughly finished; aperture rounded on a slight neck.

Length of holotype 1.77 mm, greatest diameter of coiled part 0.75 mm, greatest width of uniserial portion 0.68 mm, width from center of side through opposite angle 0.39 mm; greatest diameter of coil in figured paratype 0.55 mm. Other specimens vary from 0.65 mm to 1.92 mm in length and in diameter of early coiled part from 0.39 mm to 0.75 mm.

Types and occurrence.—Holotype (U.S.N.M. no. 106017) and unfigured paratypes (U.S.N.M. no. 106018) from 99 feet above the base of the Rierdon formation, unfigured paratypes (U.S. N.M. no. 106019) from 104 feet above base of Rierdon formation, unfigured paratypes (U.S. N.M. no. 106020) from 134 feet above the base of the Rierdon formation, all from locality 5; figured paratype (U.S.N.M. no. 106021) and unfigured paratypes (U.S.N.M. no. 106022) from 81 feet above the base of the Rierdon formation, unfigured paratypes (U.S.N.M. no. 106023) from 33 feet above the base of the Rierdon formation, all from locality 1; unfigured paratypes (U.S.N.M. no. 106024) from the Stockade Beaver shale member of the Sundance, 47 to 52 feet above the base, at locality 4. Wickenden recorded the species from about the middle of the Jurassic sequence in the subsurface of Saskatchewan. *Frankeina* in the western interior Jurassic is common in the calcareous shales of the Rierdon and equivalent strata, and with the exception of an occurrence of a related species (U.S.N.M. no. 106025) in the lower part of the Swift formation (*Quenstedtoceras collieri* zone) in the Little Rocky Mountains, it appears to be restricted to this interval.

Remarks.—This species is closer to *Frankeina incerta* Alexander and Smith, from the Lower Cretaceous of Texas, than to any other described species, in size and in having a comparatively large coil. The Jurassic form differs in having a more pronounced coil, of diameter equal to the breadth of the later triangular portion, and in lacking the *Flabellammina* stage characteristic of *F. incerta*, before the triangular character appears. The chambers do not enlarge so rapidly, the sides are more excavated and the sutures are more distinct in *F. commutata*, n. sp.

Family LAGENIDAE

Subfamily NODOSARIINAE

Genus **Lenticulina** Lamarck, 1804

Lenticulina dilecta Loeblich and Tappan, n. sp.
Pl. 1, figs. 5a–8

Lenticulina helios (Terquem), Sandidge, Amer. Midland Nat. **14:** 178, pl. 1, figs. 1–2. 1933.

Lenticulina sarthacensis (Schwager), Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27:** p. 160, pl. 1, figs. 9 and 11 (not fig. 10). 1933.

Test free, lenticular, of medium size, close-coiled, but not completely involute, earlier coils visible in the umbilical region, generally planispiral, but occasional specimens distinctly trochoid, periphery subacute, with a keel; chambers numerous, increasing in size as added, 9 to 11 in the final whorl, depressed centrally; sutures slightly curved, distinct, raised and limbate, occasionally with minute lateral projections on the surface; wall calcareous, hyaline, surface ornamented by the peripheral keel, the elevated sutures which are thickest and highest toward the umbonal area, and the depressed umbilicus, with an encircling ridge formed by the coalescing ends of the sutures; aperture at the peripheral angle, rounded, occasionally faintly crenulated at the margins, showing a tendency toward the radiate character of younger species of the genus.

Greatest diameter of holotype 0.70 mm, least diameter 0.49 mm, greatest thickness 0.26 mm. Other specimens are from 0.34 mm to 0.81 mm in greatest diameter.

Types and occurrence.—Holotype (U.S.N.M. no. 106026), figured paratypes (U.S.N.M. no. 106027 a–c) and unfigured paratypes (U.S.N.M. no. 106028) from 104 feet above the base of the Rierdon formation, unfigured paratypes (U.S. N.M. no. 106029) from 99 feet above the base of the Rierdon formation, all from locality 5; unfigured paratypes (U.S.N.M. no. 106030) from the Rierdon formation, 33 feet above the base, at locality 1; unfigured paratypes (U.S.N.M. nos. 106031 to 106034) from cuttings in the Sundance formation at depths of 4,185–4,190, 4,195–4,200, 4,205–4,210, and 4,245–4,250 at locality 7.

Remarks.—This species differs from *Cristellaria helios* Terquem in being biumbilicate rather than biumbonate, in having fewer chambers, in being about one-half as large, and in having comparatively greater thickness.

Genus **Astacolus** Montfort, 1808

Astacolus ectypus Loeblich and Tappan, n. sp.
Pl. 1, figs. 14–18b

Lenticulina sculpta (Terquem and Berthelin), Sandidge, Amer. Midland Nat. **14:** 179, pl. 1, fig. 10. 1933.

Lenticulina sarthacensis (Schwager), Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27:** 160, pl. 1, figs. 10a–b (not figs. 9 and 11). 1933.

Test free, large, auriculate to elongate in outline, early portion close-coiled, later uncoiling, with chambers extending back nearly or completely to the coil on the ventral margin, microspheric individuals showing a more enrolled early portion and broader test, while megalospheric forms are narrower and more evolute and elongate, periphery acute, keeled, ventral face truncate; chambers numerous, as many as 16 in well-developed microspheric specimens, as many as 11 in megalospheric specimens, sharply inflated just anterior to the sutures, well preserved specimens showing a distinct ridge which roughly parallels the sutures but sometimes is more strongly curved toward the aperture in the central portion of the test; sutures distinct, deeply depressed, curved; wall calcareous, hyaline, surface smooth, with no ornamentation other than the peripheral keel and the previously mentioned ridge paralleling the sutures; aperture at the peripheral angle, radiate.

Length of megalospheric holotype 0.70 mm, greatest breadth of coil 0.34 mm, greatest breadth above coil 0.31 mm, greatest thickness 0.21 mm. Length of microspheric paratype 0.78 mm, greatest breadth 0.42 mm, greatest thickness 0.21 mm. Other specimens vary in length from 0.36 to 0.86 mm.

Types and occurrence.—Holotype (U.S.N.M. no. 106035), figured paratypes (U.S.N.M. no. 106036a–c), and unfigured paratypes (U.S.N.M. no. 106037) from 47 to 52 feet above the base of the Stockade Beaver shale member of the Sundance formation at locality 4; unfigured paratypes (U.S.N.M. no. 106038) from 99 feet above the base, figured paratype (U.S.N.M. no. 106039) and unfigured paratypes (U.S.N.M. no. 106040) from 104 feet above the base, unfigured paratypes (U.S.N.M. no. 106041) from 134 feet above the base, all from the Rierdon formation at locality 5; unfigured paratypes (U.S.N.M. no. 106042) from 55 feet above the base and unfigured paratypes (U.S.N.M. no. 106043) from 81 feet above the base, both from the Rierdon formation at locality 1; unfigured paratypes (U.S.N.M. no. 106044) from the Sundance formation, in cuttings at 4,180–4,185 feet, at locality 7.

Remarks.—This species is similar to *Cristellaria sarthacensis* Schwager but differs in lacking the raised sutures and in being more evolute. In *A. ectypus*, n. sp., the sutures are depressed, but the chambers are inflated just anterior to the sutures, forming a distinct ridge. *Astacolus ectypus*, n. sp., differs from *Cristellaria sculpta* Terquem and Berthelin in being nearly twice as large and in having a much less well defined keel.

Wickenden (1933, p. 160) included under *Lenticulina sarthacensis* (Schwager) a specimen of this species, as well as specimens similar to those here described as *Lenticulina dilecta*, n. sp. *Astacolus ectypus*, n. sp., differs from *L. dilecta*, n. sp., in having a smaller coiled portion, with the later chambers uncoiling, in having strongly inflated chambers and depressed sutures rather than elevated and spinose sutures, and in lacking the open umbilicus.

Astacolus petalus Loeblich and Tappan, n. sp.
Pl. 1, figs. 19–21b

Test free, of medium size, auriculate in outline, much compressed, sides flat and parallel, early portion coiled, later uncoiling, later chambers extending back toward the proloculus on the ventral margin, periphery subtruncate; chambers numerous, as many as 10 or 11 in larger specimens, increasing very slightly in height as added, but increasing rapidly in breadth, so that later chambers are four to five times as broad as high; sutures gently curved, very slightly depressed, varying from quite distinct and clear in some specimens to somewhat obscure in others, so that they can be well distinguished only when the specimen is dampened; wall calcareous, hyaline, surface smooth; aperture at the peripheral angle, radiate.

Length of holotype 0.88 mm, greatest breadth 0.44 mm, greatest thickness 0.10 mm. Other specimens are from 0.39 mm to 0.91 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106045), figured paratypes (U.S.N.M. 106046a–b), and unfigured paratypes (U.S.N.M. no. 106047) from 47 to 52 feet above the base of the Stockade Beaver shale member of the Sundance formation at locality 4; unfigured paratypes (U.S.

N.M. no. 106048) from 55 feet above the base of the Rierdon formation and (U.S.N.M. no. 106049) from 81 feet above the base of the Rierdon formation, both from locality 1; unfigured paratypes (U.S.N.M. no. 106050) from 99 feet above the base of the Rierdon formation at locality 5.

Remarks.—*Astacolus petalus*, n. sp., is similar to *Cristellaria acuminata* Terquem but is nearly one-third smaller and has a less enrolled early portion. It differs from *Cristellaria anceps* Terquem in being nearly twice as large and in having less embracing chambers.

Genus **Marginulinopsis** Silvestri, 1904

Marginulinopsis phragmites Loeblich and Tappan, n. sp.

Pl. 1, figs. 22–23b; text fig. 1.

Marginulina cf. *lacunata* (Terquem), Sandidge, Amer. Midland Nat. **14:** 180, pl. 1, figs. 6–8. 1933.

Marginulina cf. *lacunata* (Terquem and Berthelin), Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27:** 162, pl. 1, fig. 13. 1933.

Marginulina cf. *sparsa* (Terquem and Berthelin), Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27:** p. 161, pl. 1, fig. 14. 1933.

Test free, elongate, robust, early portion coiled, later portion rectilinear, rounded to slightly flattened in section; chambers numerous, increasing in size as added, as many as 10; sutures straight, radiate at first, later horizontal, obscured by the surface ornamentation; wall calcareous, hyaline, surface ornamented by 10 to 12 very strongly elevated costae, which are continuous across the sutures; aperture radiate, terminal, produced on a short neck.

Length of holotype 0.96 mm, greatest diameter of coil 0.26 mm, greatest breadth of uniserial portion 0.36 mm, greatest thickness 0.29 mm. Other specimens vary from 0.23 to 0.96 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106051), figured paratype (U.S.N.M. no. 106052), and unfigured paratypes (U.S.N.M. no. 106053) from the Stockade Beaver shale member of the Sundance formation, 47 to 52 feet above the base at locality 4; unfigured paratypes (U.S. N.M. no. 106054) from 33 feet above the base, figured paratype (U.S.N.M. no. 106055) and unfigured paratypes (U.S.N.M. no. 106056) from 55 feet above the base, unfigured paratypes (U.S.N.M. no. 106057) from 81 feet above the base, all from the Rierdon formation at locality 1; unfigured paratypes from 99 feet (U.S.N.M. 106058), 104 feet (U.S.N.M. no. 106059), and 134 feet (U.S.N.M. no. 106060) above the base of the Rierdon formation at locality 5; unfigured paratypes from 4,185–4,190 feet, (U.S.N.M. no. 106061), 4,195–4,200 feet (U.S.N.M. no. 106062), 4,200–4,205 feet (U.S.N.M. no. 106063), 4,205–4,210 feet (U.S.N.M. no. 106064), and 4,245–4,250 feet (U.S.N.M. no. 106065), all from cuttings in the Sundance formation at locality 7.

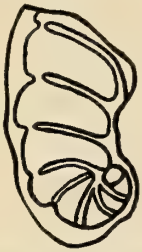

Fig. 1.—*Marginulinopsis phragmites* Loeblich and Tappan, n. sp.: Paratype (U.S.N.M. no. 106055), section showing globular proloculus and cristellarian coil, followed by uniserial chambers. × 72.

Remarks.—*Marginulinopsis phragmites*, n. sp., is similar to *Cristellaria* (*Marginulina*) *jonesi* Reuss but is about one-half as large and has fewer ribs, which in most specimens traverse all the chambers. In *Cristellaria* (*Marginulina*) *jonesi* Reuss the ribs do not traverse the final chamber. *Marginulinopsis phragmites*, n. sp., differs from *Cristellaria lacunata* Terquem and Berthelin in possessing more ribs and in being much smaller. It differs from *Cristellaria sparsa* Terquem and Berthelin in possessing fewer ribs and in being of much larger size.

Genus **Vaginulinopsis** Silvestri, 1904

Vaginulinopsis eritheles Loeblich and Tappan, n. sp.

Pl. 1, figs. 9a–13

Marginulina sp.? Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27:** p. 163, pl. 1, figs. 12a–b. 1933.

Test free, large, elongate, early portion close-coiled and cristellarian in character, strongly inflated centrally, with an umbonal boss, periphery with a distinct keel, later portion uncoiling with periphery broadly rounded, microspheric forms broader and larger, with a better-developed coil than in the megalospheric specimens; chambers numerous, low and broad, as many as 12 in the final whorl of the microspheric form and 7 to 9 in the megalospheric form, followed by 2 to 4 uncoiled chambers which are inflated near the ventral margin and flattened toward the dorsal margin, so that the uniserial chambers are ovate to subtriangular in section; sutures slightly curved and flush with the surface in the cristellarian portion, distinct to obscure, depending on the preservation of the specimen in question, depressed, nearly straight and quite distinct in the uncoiled portion; wall calcareous, hyaline, surface smooth; aperture radiate, at the peripheral angle which is somewhat produced.

Length of megalospheric holotype 0.96 mm, greatest breadth of coil 0.47 mm, greatest breadth of uniserial portion 0.29 mm, greatest thickness 0.23 mm. Length of microspheric paratype 1.40 mm, greatest breadth of coiled portion 0.62 mm, greatest breadth of uniserial portion 0.49 mm, greatest thickness 0.36 mm. Other specimens are from 0.44 mm to 1.40 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106066), figured paratypes (U.S.N.M. nos. 106067a–d), and unfigured paratypes (U.S.N.M. no. 106068) from the Stockade Beaver shale member of the Sundance formation, 47 to 52 feet above the base, at locality 4; unfigured paratypes (U.S.N.M. no. 106069) from 99 feet above the base and unfigured paratypes (U.S.N.M. no. 106070) from 104 feet above the base of the Rierdon formation, both from locality 5; unfigured paratypes (U.S.N.M. no. 106071) from 33 feet above the base, and unfigured paratypes (U.S. N.M. no. 106072) from 81 feet above the base, both from the Rierdon formation at locality 1; unfigured paratype (U.S.N.M. no. 106073) from the Sundance formation, in cuttings at 4,205–4,210 feet at locality 7.

Remarks.—This species resembles *Cristellaria centralis* Terquem from the Upper Bajocian of France in size and general appearance but is less compressed and has more horizontal and less depressed sutures. *Vaginulinopsis eritheles*, n. sp. differs from *Cristellaria vetusta* d'Orbigny in lacking the limbate sutures in the early part, in possessing depressed sutures in the later part, and in being of slightly larger size.

Genus **Dentalina** d'Orbigny, 1826

Dentalina gracilistriata Loeblich and Tappan, n. sp.

Pl. 1, figs. 24a-b

Test free, elongate, arcuate, of medium size; chambers uniserially arranged, slightly inflated centrally, increasing gradually in diameter as added, and more rapidly in length so that the final chambers are of somewhat greater length than breadth; sutures distinct, straight, slightly constricted; wall calcareous, hyaline, surface ornamented with numerous very fine wavering ribs, about 18 to 20 in number; aperture terminal, rounded, with margins showing indentations suggestive of a radiate character.

Length of holotype 0.81 mm, greatest breadth 0.16 mm.

Type and occurrence.—Holotype (U.S.N.M. no. 106074) from 47 to 52 feet above the base of the Stockade Beaver shale member of the Sundance formation at locality 4.

Remarks.—This species is somewhat similar to *Dentalina cylindrica* Schwager but differs in having lower chambers and in being ornamented by fine ribs. It differs from *D. fraasi* Schwager in having a less acuminate base and in possessing the fine ribs.

Dentalina ochyra Loeblich and Tappan, n. sp.

Pl. 1, figs. 25a–b

Test free, elongate, robust, slightly arcuate; chambers uniserially arranged, as many as 8 in well-developed specimens, increasing gradually in size as added from the rounded base, final chamber occasionally of somewhat less diameter than the preceding chamber; sutures straight, at right angles to the axis, occasionally slightly constricted, generally obscure; wall calcareous, hyaline, surface ornamented with about 16 to 18 low and narrow but continuous ribs of considerable regularity, increasing in number by intercalation as the test diameter increases; aperture terminal, radiate, on a short neck.

Length of holotype 1.07 mm, maximum diameter 0.26 mm. Other specimens varying in length from 0.44 mm to 1.09 mm.

Types and occurrence.—Holotype (U.S.N.M. no. 106075) and unfigured paratypes (U.S.N.M. no. 106076) from the Stockade Beaver shale member of the Sundance formation, 47 to 52 feet above the base, at locality 4; unfigured paratypes (U.S. N.M. no. 106077) from 139 feet above the base and unfigured paratypes (U.S.N.M. no. 106078) from 81 feet above the base, both from the Rierdon formation at locality 1; unfigured paratypes (U.S.N.M. no. 106079) from the Rierdon formation, 15 feet above the base, at locality 2; unfigured paratypes (U.S.N.M. no. 106080) from the Rierdon formation, 134 feet above the base, at locality 5.

Remarks.—This species somewhat resembles *Dentalina pectinata* Terquem, from the Upper

Bajocian of France, in general appearance and in having numerous ribs, but it is about twice as large and the test is almost cylindrical instead of constricted at the sutures. It is similar to *Dentalina confluens* Reuss but has less oblique sutures and is approximately one half as large.

Dentalina polyholca Loeblich and Tappan, n. sp.

Pl. 1, figs. 26–28

Test free, elongate, rectilinear, tapered or subcylindrical; chambers numerous, as many as 10, increasing gradually in size from the rounded proloculus in the microspheric specimens, but increasing very little in height or diameter in the megalospheric forms, final chamber sometimes of reduced size; sutures fairly distinct, straight, slightly constricted; wall calcareous, hyaline, surface ornamented with numerous fine ribs, about 20 to 25 in number, which are slightly undulating and occasionally bifurcate; aperture terminal, radiate, on a slight neck.

Length of microspheric holotype 1.20 mm, greatest diameter 0.21 mm; length of megalospheric paratype 0.70 mm, greatest diameter 0.18 mm. Other specimens are from 0.49 mm to 1.20 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106081) and unfigured paratypes (U.S.N.M. no. 106082) from the Rierdon formation, 15 feet above the base, at locality 2; figured paratypes (U.S.N.M. no. 106083) and unfigured paratypes (U.S.N.M. no. 106084) from the Stockade Beaver shale member of the Sundance formation, 47 to 52 feet above the base, at locality 4; unfigured paratype (U.S.N.M. no. 106085) from the Rierdon formation, 134 feet above the base, at locality 5; unfigured paratype (U.S.N.M. no. 106086) from the Rierdon formation, 81 feet above the base, at locality 1.

Remarks.—This species is similar to *D. angusticosta* Cushman, but has a more robust test and is about one-half as large. It is somewhat similar to *Nodosaria amphioxys* Reuss but has many more ribs, less constricted chambers, and an excentric aperture.

Genus **Nodosaria** Lamarck, 1812

Nodosaria orthostoecha Loeblich and Tappan, n. sp.

Pl. 1, figs. 33a–b

Nodosaria cf. *corallina* Gümbel, Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27**: 165, pl. 2, fig. 11. 1933.

Test free, elongate, rectilinear, of medium size; chambers numerous, as many as 7, varying from subglobular to somewhat broader than high, increasing very little in diameter as added, in many specimens the proloculus is of greater diameter than any of the succeeding chambers; sutures distinct, straight, constricted; wall calcareous, hyaline, surface ornamented with about 12 to 13 straight, narrow, longitudinal costae; aperture radiate, terminal, on a short neck.

Length of holotype 0.94 mm, greatest breadth 0.21 mm. Other specimens vary from 0.23 mm to 0.94 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106087) and unfigured paratypes (U.S.N.M. no. 106088) from the Rierdon formation, 55 feet above the base, at locality 1; unfigured paratypes (U.S.N.M. no. 106089) from the Rierdon formation, 134 feet above the base, at locality 5; unfigured paratypes (U.S.N.M. no. 106090) from the Rierdon formation, 15 feet above the base, at locality 2.

Remarks.—This species is similar to *Nodosaria fontinensis* Terquem, but is about one-third smaller, has slightly lower chambers, and considerably more numerous ribs. It differs from *Nodosaria hortensis* Terquem in being nearly one-third larger and in having many more ribs.

Nodosaria sphingothalama Loeblich and Tappan, n. sp.

Pl. 1, figs. 34a–b

Test free, large, stout, elongate, rectilinear; chambers subglobular, increasing gradually in size, numerous, as many as five may be present, although specimens are usually fragmental due to the delicate nature of the test; sutures distinct, straight, strongly constricted, so that the tests are frequently broken at the sutures; wall calcareous, hyaline, surface ornamented with about 22 strong, coarse, straight, longitudinal costae, which are somewhat less prominent at the sutures; aperture terminal, radiate, on a distinct neck.

Length of holotype 0.99 mm, greatest breadth 0.34 mm. Other specimens are from 0.73 mm to 1.27 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106091) and unfigured paratypes (U.S.N.M. no. 106092) from the Rierdon formation, 55 feet above the base, at locality 1; unfigured paratypes (U.S.N.M. no. 106093) from the Rierdon formation, 15 feet above the base, at locality 2.

Remarks.—This species is similar to specimens figured by Terquem under the name *Nodosaria fontinensis*, but differs in being nearly twice as large and in having fewer but more prominent costae.

Genus **Lingulina** d'Orbigny, 1826

Lingulina charagmata Loeblich and Tappan, n. sp.
Pl. 1, figs. 31a–b

Test free, flattened, of medium size, rhomboidal in outline, periphery subacute; chambers numerous, low and equitant, very highly arched, as many as 10 in large specimens; sutures distinct, forming an acute angle toward the aperture, somewhat elevated and thickened; wall calcareous, hyaline, with fairly large perforations, giving a pitted appearance; aperture terminal, elongate.

Length of holotype 0.52 mm, greatest breadth 0.34 mm, thickness 0.08 mm. Other specimens are from 0.29 mm to 0.73 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106094) and unfigured paratypes (U.S.N.M. no. 106095) from the Rierdon formation, 15 feet above the base, at locality 2; unfigured paratypes (U.S.N.M. no. 106096) from the Stockade Beaver shale member of the Sundance formation, 47 to 52 feet above the base, at locality 4.

Remarks.—This species is similar to *Frondicularia oolithica* Terquem, but is twice as large, has less acutely angled sutures, and a less compressed test.

Lingulina hathra Loeblich and Tappan, n. sp.
Pl. 1, figs. 29a–30

Frondicularia cf. *franconica* Gümbel, Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27:** p. 164, pl. 2, fig. 5. 1933.

Frondicularia lingulaeformis Schwager, Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27:** p. 164, pl. 2, figs. 4 and 10. 1933.

Test free, large, elongate, flattened, periphery rounded, extremely variable in outline, some specimens elongate with parallel sides, as in the holotype, others palmate with tapered base, and still others comparatively narrow and elongate and almost cylindrical, large suites of specimens showing all gradations between these extremes; equitant chambers increasing gradually in size from the rounded proloculum, low and broad, as many as 10; sutures distinct, slighty depressed or flush with the surface, occasionally slightly constricted; wall calcareous, hyaline, surface ornamented with numerous very fine striae which tend to converge toward the middle of the broad test, at the apertural ends of the chambers; aperture terminal, radiate, on a slight neck.

Length of holotype 1.35 mm, greatest breadth 0.29 mm, greatest thickness 0.18 mm. Other specimens are from 0.36 to 1.35 mm in length.

Types and occurrence.—Holotype (U.S.N.M. No. 106097), figured paratype (U.S.N.M. no. 106098), and unfigured paratypes (U.S.N.M. no. 106099) from the Stockade Beaver shale member of the Sundance formation, 47 to 52 feet above the base, at locality 4; unfigured paratypes (U.S.N.M. no. 106100) from the Rierdon formation, 55 feet above the base, at locality 1; unfigured paratypes from 4,180–4,185 feet (U.S.N.M. no. 106101), 4,195–4,200 feet (U.S.N.M. no. 106102), 4,215–4,220 feet (U.S.N.M. no. 106103), and 4,320–4,325 feet (U.S.N.M. no. 106104), all from cuttings in the Sundance formation at locality 7.

Remarks.—This species differs from *Frondicularia laevissima* Terquem in having lower chambers and in possessing the abundant fine striae. It may be distinguished from *Frondicularia franconica* Gümbel by its slightly larger size, more broadly angled sutures, less flaring test, and less distinct apertural neck. It is differentiated from *Frondicularia lingulaeformis* Schwager in being about six times as large, in having higher chambers, more acutely angled sutures, and a less acuminate base.

Lingulina rursa Loeblich and Tappan, n. sp.
Pl. 1, figs. 32a–b

Test elongate, narrow, tapering, much compressed, periphery sub-acute; chambers numerous, low and broad, equitant, 10 to 13 in large specimens, increasing fairly rapidly in breadth as added in the early part, later increasing more slowly; sutures very slightly depressed, strongly arched centrally, forming an acute angle, somewhat obscure unless specimens are dampened; wall calcareous, hyaline, surface smooth; aperture terminal, elongate.

Length of holotype 0.83 mm, greatest breadth 0.23 mm, greatest thickness 0.08 mm. Other specimens are from 0.26 mm to 0.83 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106105) and unfigured paratypes (U.S.N.M. no. 106106) from 139 feet above the base of the Rierdon formation, unfigured paratypes

(U.S.N.M. no. 106107) from 55 feet above the base of the Rierdon formation, all from locality 1; unfigured paratypes (U.S.N.M. no. 106108) from the Rierdon formation, 15 feet above the base, at locality 2; unfigured paratypes (U.S.N.M. no. 106109) from the Stockade Beaver shale member, 47 to 52 feet above the base, at locality 4; unfigured paratypes from 99 feet above the base (U.S.N.M. no. 106110), 104 feet above the base (U.S.N.M. no. 106111), and 134 feet above the base (U.S.N.M. no. 106112), all from the Rierdon formation at locality 5.

Remarks.—This species is similar to *Frondicularia oolithica* Terquem, but is approximately one-third larger and has less limbate sutures and the test is more compressed.

Genus **Tristix** Macfadyen, 1941

Tristix nitidula Loeblich and Tappan, n. sp.
Pl. 1, figs. 37a–b

Dentalinopsis oölithica ? (Terquem), Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27**: p. 167, pl. 2, figs. 6a–b. 1933.

Test free, elongate, narrrow, tapering slightly toward the base, triangular in section, angles rounded; chambers numerous, six in the holotype, increasing very little in height as added except that the final chamber is proportionately larger than earlier chambers; sutures flush with the surface, indistinct unless specimen is dampened, slightly arched in the center of the sides, curving downward at the angles; wall calcareous, hyaline, surface smooth; aperture terminal, rounded.

Length of holotype 0.73 mm, greatest breadth across side 0.23 mm.

Types and occurrence.—Holotype (U.S.N.M. no. 106113) from the Stockade Beaver shale member, 47 to 52 feet above the base, at locality 4.

Remarks.—*Tristix nitidula*, n. sp., differs from *Tritaxia oölithica* Terquem in having a more slender test and more rounded angles, as seen in cross section. It differs from *Tristix liasina* (Berthelin) in being considerably larger and in having more rounded angles.

Genus **Vaginulina** d'Orbigny, 1826

Vaginulina mecyna Loeblich and Tappan, n. sp.
Pl. 1, figs. 38a–b

Test free, elongate, narrow, compressed, triangular in side view; chambers numerous, as many as 12, low and broad, highest dorsally, increasing gradually in breadth as added; sutures distinct, oblique, highest at the dorsal margin, thickened and slightly depressed; wall calcareous, hyaline, surface smooth; aperture terminal at the dorsal angle, on a slight neck-like extension of the final chamber, rounded, but with faint radiate markings.

Length of holotype 1.25 mm, greatest breadth 0.29 mm, greatest thickness 0.10 mm. Other specimens range from 0.65 to 1.38 mm in length.

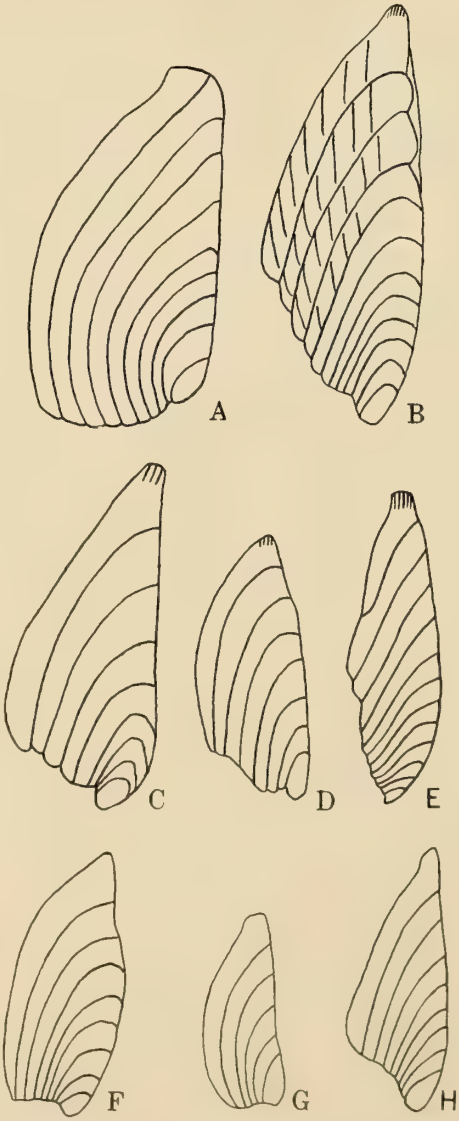

FIG. 2.—*Citharina latissima* Loeblich and Tappan, n. sp., paratypes: A (U.S.N.M. no. 103152), B to H (U.S.N.M. nos. 106155 a–g), showing variation in outline and ornamentation. × 41.

Types and occurrence.—Holotype (U.S.N.M. no. 106148) and unfigured paratypes (U.S.N.M. no. 106149) from the Rierdon formation, 15 feet above the base, at locality 2.

Remarks.—*Vaginulina mecyna*, n. sp., is similar to *Marginulina solida* Terquem var. F of Terquem, but it is about a third larger and has a more tapering base, more numerous chambers, slenderer form, and a more produced final chamber.

Genus **Citharina** d'Orbigny, 1839

Citharina latissima Loeblich and Tappan, n. sp.
Pl. 1, figs. 40a–b; text figs. 2A–H

Test free, large, elongate, much compressed, triangular in side view but varied in outline, periphery truncate; chambers numerous, low and broad, increasing rapidly in breadth as added, increasing very little in height, highest dorsally; sutures distinct, thickened, slightly depressed, curving gently from near the proloculus at the ventral margin to a much higher position on the dorsal margin; wall calcareous, hyaline, surface smooth, except where ornamented by very low and narrow ribs that cross the chambers obliquely and are interrupted by the sutures, number of ribs present is variable, all gradations being observed from smooth tests to those completely covered with the ribs; aperture terminal, radiate, on a short neck at the dorsal angle.

Length of holotype 1.61 mm, greatest breadth 0.60 mm, greatest thickness 0.10 mm. Other specimens range from 0.26 to 2.00 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106150) and unfigured paratypes (U.S.N.M. no. 106151) from the Stockade Beaver shale member, 47 to 52 feet above the base, at locality 4; figured paratype (U.S.N.M. no. 106152) from 33 feet above the base, unfigured paratypes from 55 feet above the base (U.S.N.M. no. 106153), 81 feet above the base (U.S.N.M. no. 106154), figured paratypes (U.S.N.M. no. 106155) and unfigured paratypes (U.S.N.M. no. 106156) from 139 feet above the base, all from the Rierdon formation at locality 1; unfigured paratypes from 99 feet above the base (U.S.N.M. no. 106157), 104 feet above the base (U.S.N.M. no. 106158), and 134 feet above the base (U.S.N.M. no. 106159), all from the Rierdon formation at locality 5.

Remarks.—A few of the variations in outline are shown in the accompanying text figures. This species is similar to *Marginulina condita* Terquem, but the American species differs in having fewer and less prominent costae, and in general the chambers are more overhanging.

Genus **Citharinella** Marie, 1938

Citharinella compara Loeblich and Tappan, n. sp.
Pl. 1, figs. 36a–b; text figs. 3A–D

Test free, elongate, palmate, increasing gradually in size, early portion citharine, later portion frondicularian, periphery subacute; chambers numerous, only three to four citharine chambers followed by as many as seven highly arched equitant chambers that form an acute angle distally; sutures distinct, slightly depressed, strongly oblique in the citharine portion, highly arched in the frondicularian portion; wall calcareous, hyaline, surface smooth, ornamented by numerous very fine low ribs; aperture terminal, radiate, on a slight neck.

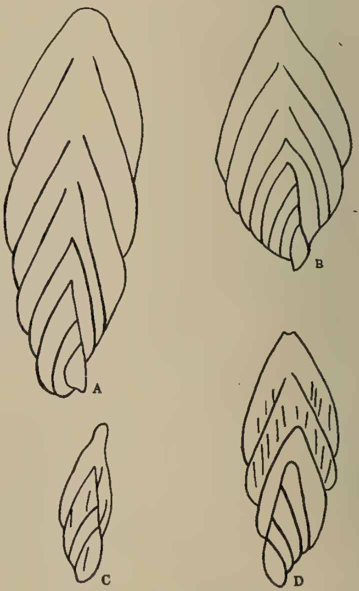

FIG. 3.—*Citharinella compara* Loeblich and Tappan, n. sp., paratypes: A–D (U.S.N.M. nos. 106161a–d), showing variation in outline and ornamentation. × 36.

Length of holotype 1.43 mm, greatest breadth 0.47 mm, greatest thickness 0.10 mm. Other specimens are from 0.39 to 1.43 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106160), figured paratypes (U.S.N.M. nos. 106161a–d), and unfigured paratypes (U.S.N.M. no. 106162) from the Stockade Beaver shale member, 47 to 52 feet above the base, at locality 4; unfigured paratypes from 99 feet above the base (U.S.N.M. no. 106163) and 134 feet above the base (U.S.N.M. no. 106164), both from the Rierdon formation, at locality 5; unfigured paratypes from 55 feet above the base (U.S.N.M. no. 106165), 139 feet above the base (U.S.N.M. no. 106166), both from the Rierdon formation, at locality 1; unfigured paratypes (U.S.N.M. no. 106167) from the Rierdon formation, 15 feet above the base, at locality 2; unfigured paratype (U.S.N.M. no. 106168) from cuttings at 4,210–4,215 feet in the Sundance formation at locality 7.

Remarks.—*Citharinella compara*, n. sp., is distinguished from *Flabellina jurensis* Franke by its slightly larger size, less arcuate initial portion and its ornamentation of numerous fine ribs.

Citharinella latifolia Loeblich and Tappan, n. sp.
Pl. 1, figs. 35a–b; text figs. 4A–C

Test free, palmate, short and robust, compressed, periphery truncate; chambers numerous, citharine portion reduced, generally consisting of only two or three chambers, followed by as many as six equitant chambers that are much broader but of nearly the same height as the early chambers; sutures distinct, slightly depressed, arched centrally, forming almost a right angle toward the aperture; wall calcareous, hyaline, surface ornamented by numerous rather coarse costae of about the same width as the depressions between costae; aperture terminal, radiate, on a slight neck.

Length of holotype 0.99 mm, greatest breadth 0.47 mm, greatest thickness 0.10 mm. Other specimens are from 0.65 to 1.12 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106169), figured paratypes (U.S.N.M. no. 106170), and unfigured paratypes (U.S.N.M. no. 106171) from the Stockade Beaver shale member, 47 to 52 feet above the base, at locality 4; unfigured paratype (U.S.N.M. no. 106172) from the Rierdon formation, 15 feet above the base, at locality 2; unfigured paratypes (U.S.N.M. no. 106173) from 33 feet above the base and (U.S.N.M. no. 106174) from 55 feet above the base, both from the Rierdon formation, at locality 1.

Remarks.—This species differs from *Flabellina jurensis* Franke in having a much broader test and in being ornamented by rather coarse costae. It differs from *Flabellina karreri* Berthelin in lacking the extremely acuminate early portion and by having chambers which are less strongly recurved.

Genus **Tribrachia** Schubert, 1912

Genotype (here designated).—*Tribrachia inelegans* Loeblich and Tappan, n. sp.

Schubert described the genus *Tribrachia* in 1912, for the tri-radiate frondicularian Foraminifera, but cited no species. As the species *Tribrachia inelegans* Loeblich and Tappan, here described, is the first species to be published in connection with the generic name *Tribrachia*, it thus becomes the genotype. Previously described species that rightfully belong to this genus are *Frondicularia amoena* Reuss and *Frondicularia tricarinata* d'Orbigny. These species were included by ten Dam and Schijfsma in the genus *Tricarinella*, which is, however, a synonym of *Tristix* Macfadyen. *Tristix* and *Tribrachia* are quite distinct, the former having the appearance of a triradiate *Lingulina* whereas the latter is more similar to a triradiate *Frondicularia*.

Cushman (1948: 219) stated that "some of the Cretaceous species [of *Frondicularia*] have a supplementary angle and have been named *Tribrachia* by Schubert. The name may perhaps be used for these specialized species." Galloway (1933: 242) included *Tribrachia* in the synonomy of *Frondicularia* as "monstrosities with three edges." The writers believe Schubert's genus to be distinct from *Frondicularia*. In the Rierdon formation we have seen no species of true *Frondicularia*, and thus the species here described cannot be merely a monstrosity. We have also seen true *Tribrachia* in the American Cretaceous. Although in some horizons we have seen specimens with a third angle which were obviously monstrosities of *Citharinella*, *Palmula* and *Frondicularia*, these freakish specimens merely suggest a relationship between these lagenid genera. The occurrence of

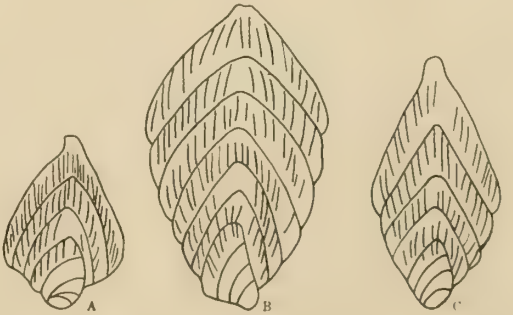

Fig. 4.—*Citharinella latifolia* Loeblich and Tappan, n. sp., paratypes: A–C (U.S.N.M. nos. 106170-a–c), showing variation in plan, outline, and ornamentation. × 36.

Tribrachia not associated with any of these genera establishes the validity of the genus.

Tribrachia inelegans Loeblich and Tappan, n. sp.
Pl. 1, figs. 39a–b

Test free, elongate, tapering, triangular in section, angles truncate; about six chambers, each trifoliate in section, with sides of each radius nearly parallel, chambers increasing in breadth as added but only slightly in height; sutures distinct, depressed, very highly arched near the central portion of the test, curving far backward toward the proloculus at the angles; wall calcareous, hyaline, surface smooth; aperture terminal, radiate.

Length of holotype 0.91 mm, greatest breadth 0.34 mm. Length of paratype 1.17 mm, greatest breadth 0.36 mm.

Types and occurrence.—Holotype (U.S.N.M. no. 106175) and unfigured paratype (U.S.N.M. no. 106176) from the Rierdon formation, 134 feet above the base at locality 5.

Remarks.—*Tribrachia inelegans*, n. sp., differs from *Frondicularia tricarinata* d'Orbigny in having a somewhat smaller and comparatively broader test. It is differentiated from *Frondicularia amoena* Reuss by its broader test and more acutely angled sutures.

Family SPIRILLINIDAE

Genus **Turrispirillina** Cushman, 1927

Turrispirillina spirella Loeblich and Tappan, n. sp.
Pl. 1, figs. 41a–b

Cornuspira orbicula (Terquem and Berthelin), Sandidge, Amer. Midland Nat. **14:** 178, pl. 1, fig. 14. 1933.

Test free, small, consisting of a proloculus and elongate, tubular, evolutely coiled second chamber that forms a low conical spire, concave ventrally; spiral suture distinct; wall calcareous, hyaline, surface smooth; aperture rounded, at the end of the tube.

Greatest diameter of holotype 0.29 mm, greatest thickness 0.05 mm. Other specimens are from 0.16 mm to 0.29 mm in diameter.

Types and occurrence.—Holotype (U.S.N.M. no. 106177) and unfigured paratypes (U.S.N.M. no. 106178) from the Rierdon formation, 15 feet above the base, at locality 2.

Remarks.—This species is probably the same as that recorded by Sandidge, but our specimens are not as large. It differs from *Spirillina orbicula* Terquem and Berthelin in being conically spiral rather than planispirally coiled; otherwise the two are very similar.

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EXPLANATION OF PLATE 1

1, 2.—*Ammodiscus cheradospirus* Loeblich and Tappan, n. sp.: 1, Side view of holotype (U.S.N.M. no. 106014), showing regular, evolutely planispiral coil; 2a, side view of paratype (U.S.N.M. no. 106015); 2b, edge view. × 36.

3, 4.—*Frankeina commutata* Loeblich and Tappan, n. sp.: 3a, Side view of holotype (U.S.N.M. no. 106017), showing large and prominent coil followed by triangular uniserial portion of less diameter; 3b, top view, showing rounded aperture; 4, side view of young paratype (U.S.N.M. no. 106021), showing coiled portion and initial portion of uniserial stage. × 20.

5–8.—*Lenticulina dilecta* Loeblich and Tappan, n. sp.: 5a, Side view of paratype (U.S.N.M. no. 106027a), showing trochoid character occasionally seen in this species; 5b, opposite side of trochoid paratype; 6, side view of paratype (U.S.N.M. no. 106027b), showing elevated sutures; 7a, side view of holotype (U.S.N.M. no. 106026), showing elevated sutures and depressed umbilicus with encircling ridge formed by coalescing ends of the sutures; 7b, edge view, showing peripheral keel and flattened apertural face; 8, side view of paratype (U.S.N.M. no. 106027c) showing elevated sutures with minute projecting lateral spines. × 36.

9–13.—*Vaginulinopsis eritheles* Loeblich and Tappan, n. sp.: 9a, Side view of holotype (U.S.N.M. no. 106066), showing typical megalospheric characters; 9b, edge view, showing peripheral keel; 10, side view of paratype (U.S.N.M. no. 106067a), showing rare development of *Nodosaria*-like uniserial chambers; 11, microspheric

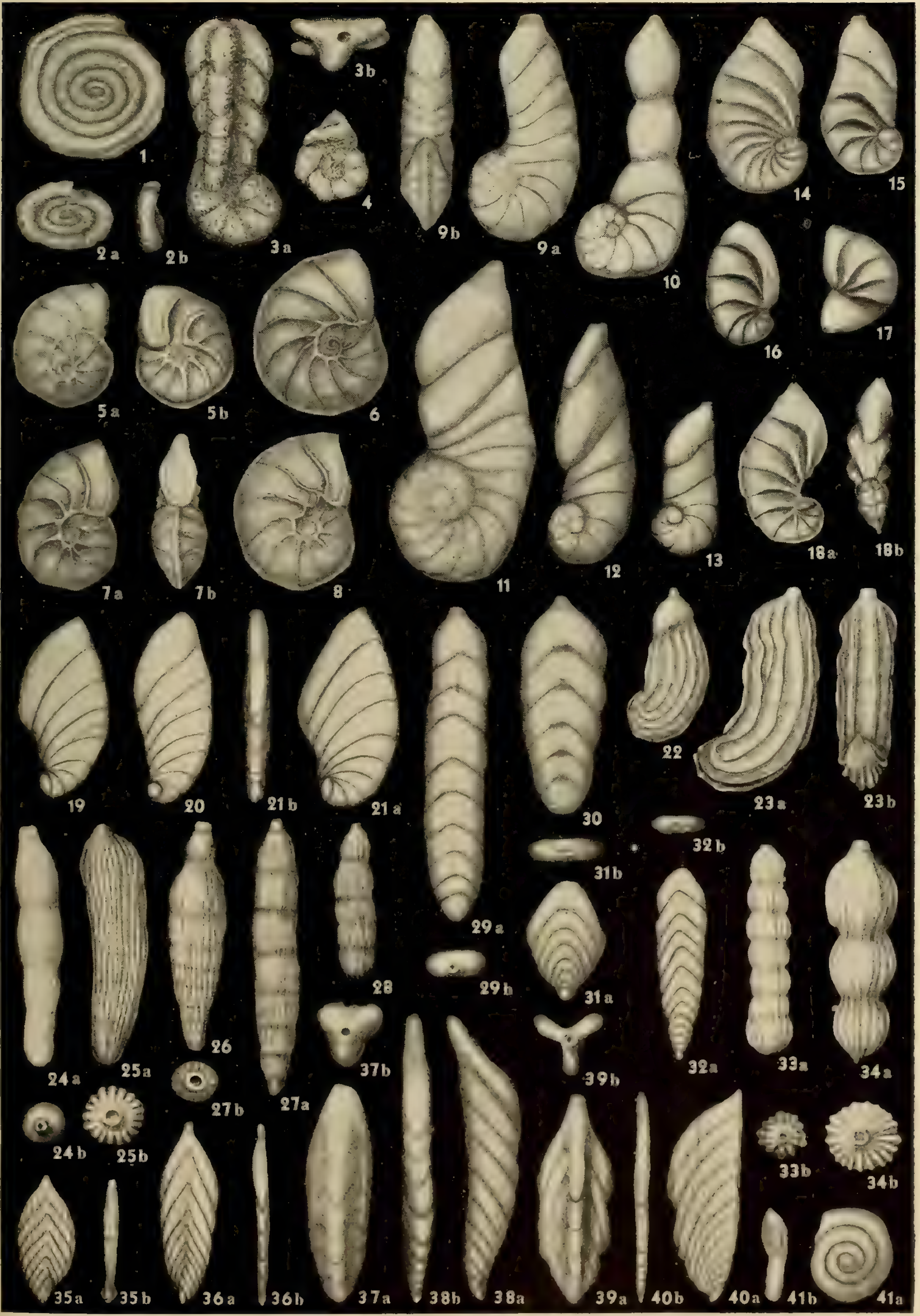

PLATE 1.—(For explanation see pages 16, 18, 19).

paratype (U.S.N.M. no. 106067b), showing large coil, and distinctly depressed sutures in the uniserial portion; 12, side view of paratype (U.S.N.M. no. 106067c), showing a more irregular development of the uniserial chambers; 13, side view of paratype (U.S.N.M. no. 106067d), a small megalospheric individual. × 36.

14–18.—*Astacolus ectypus* Loeblich and Tappan, n. sp.: 14, Side view of paratype (U.S. N.M. no. 106036a), showing auriculate outline; 15, side view of paratype (U.S. N.M. no. 106036b), showing elongate test; 16, side view of paratype (U.S.N.M. no. 106036c), showing large amount of overlap in final chamber; 17, side view of "twinned" paratype (U.S.N.M. no. 106-039); 18a, side view of holotype (U.S. N.M. no. 106035), showing depressed sutures bordered anteriorly by a sharp ridge formed by the inflation of the chamber; 18b, edge view, showing peripheral keel, deeply depressed sutures and truncate apertural face. × 36.

19–21.—*Astacolus petalus* Loeblich and Tappan, n. sp.: 19, Side view of paratype (U.S. N.M. no. 106046a) showing broad and low chambers; 20, side view of paratype (U.S.N.M. no. 106046b), showing narrower form; 21a, side view of holotype (U.S.N.M. no. 106045), showing auriculate outline and smooth character of the test; 21b, edge view, showing even thickness throughout length. × 36.

22, 23.—*Marginulinopsis phragmites* Loeblich and Tappan, n. sp.: 22, Side view of paratype (U.S.N.M. no. 106052), showing unornamented final chamber; 23a, side view of holotype (U.S.N.M. no. 106051), showing indistinct sutures and prominent costae traversing the length of the test; 23b, edge view. × 36.

24.—*Dentalina gracilistriata* Loeblich and Tappan, n. sp.: 24a, Side view of holotype (U.S.N.M. no. 106074), showing slightly arcuate test, nearly horizontal sutures, and fine striae; 24b, top view. × 48.

25.—*Dentalina ochyra* Loeblich and Tappan, n. sp.: 25a, Side view of holotype (U.S. N.M. no. 106075), showing indistinct sutures and coarse ribs; 25b, top view. × 36.

26–28.—*Dentalina polyholca* Loeblich and Tappan, n. sp.: 26, Side view of paratype (U.S.N.M. no. 106083a), showing tapering of test at both ends; 27a, side view of holotype (U.S.N.M. no. 106081), showing nearly horizontal sutures and abundant striae; 27b, top view; 28, side view of small paratype (U.S.N.M. no. 106083b), showing less acuminate base. × 36.

29, 30.—*Lingulina hathra* Loeblich and Tappan, n. sp.: 29a, Side view of holotype (U.S. N.M. no. 106097), showing comparatively narrow and elongate microspheric form; 29b, top view, showing terminal and faintly radiate aperture; 30, side view of paratype (U.S.N.M. no. 106098), showing broader and shorter megalospheric form. × 36.

31.—*Lingulina charagmata* Loeblich and Tappan, n. sp.: 31a, Side view of holotype, (U.S.N.M. no. 106094), showing rhomboidal outline and limbate highly arched sutures; 31b, top view, showing compressed form and elongate aperture. × 36.

32.—*Lingulina rursa* Loeblich and Tappan, n. sp.: 32a, Side view of holotype (U.S.N.M. no. 106105), showing narrow elongate form and sharply angled sutures; 32b, top view, showing subacute margins and elongate aperture. × 36.

33.—*Nodosaria orthostoecha* Loeblich and Tappan, n. sp.: 33a, Side view of holotype (U.S.N.M. no. 106087), showing narrow elongate test and subglobular chambers of approximately equal diameter; 33b, top view, showing numerous ribs and terminal aperture. × 36.

34.—*Nodosaria sphingothalama* Loeblich and Tappan, n. sp.: 34a, Side view of holotype (U.S.N.M. no. 106091), showing large inflated chambers, constricted sutures, and continuous ribs; 34b, top view, showing numerous ribs and radiate aperture. × 36.

35.—*Citharinella latifolia* Loeblich and Tappan, n. sp.: 35a, Side view of holotype (U.S.N.M. no. 106169), showing abbreviated early *Citharina*-like portion and coarse striae covering the test; 35b, edge view, showing bulbous early portion. × 20.

36.—*Citharinella compara* Loeblich and Tappan, n. sp.: 36a, Side view of holotype (U.S.N.M. no. 106160), showing small citharine stage followed by acutely angled frondicularian chambers with surface ornamentation consisting of fine striations; 36b, edge view, showing uniform thickness of the test. × 20.

37.—*Tristix nitidula* Loeblich and Tappan, n. sp.: 37a, Side view of holotype (U.S.N.M. no. 106113), showing moderately excavated sides and rounded angles; 37b, top view, showing terminal rounded aperture and rounded angles. × 48.

38.—*Vaginulina mecyna* Loeblich and Tappan, n. sp.: 38a, Side view of holotype (U.S.N.M. no. 106148), showing triangular form, oblique sutures, and necklike extension of the final chamber; 38b, edge view. × 36.

39.—*Tribrachia inelegans* Loeblich and Tappan, n. sp.: 39a, Side view of holotype (U.S.N.M. no. 106175), showing deeply excavated sides and acutely angled sutures; 39b, top view, showing aperture and deeply excavated sides. × 36.

40.—*Citharina latissima* Loeblich and Tappan, n. sp.: 40a, Side view of holotype (U.S.N.M. no. 106150), showing low and broad chambers, thickened sutures, and low narrow ribs; 40b, edge view, showing compressed form. × 20.

41.—*Turrispirillina spirella* Loeblich and Tappan, n. sp.: 41a, Dorsal view of holotype (U.S.N.M. no. 106177), showing globular proloculus and long, undivided second chamber; 41b, edge view, showing very low spire. × 48.

BOTANY.—Ectosperma, *a new genus of grasses from California.*[1] Jason R. Swallen, U. S. National Museum.

A very unusual and striking grass was collected by Miss Annie M. Alexander and Miss Louise Kellogg in the course of exploration in Inyo County, California, early last summer. It was submitted to the author for identification by Dr. H. L. Mason, of the University of California. It was evident at once that the grass did not belong to any species known from the United States, and on further examination it proved to be not only a new species but a new genus. One of the characters is the free caryopsis which falls from the floret very early and easily, sometimes even before it is entirely mature. The generic name selected refers to this character.

Ectosperma Swallen gen. nov.

Spiculae paniculatae 3–7-florae, rachilla continua; glumae subaequales, spicula paulo breviores, 7–11-nerves; lemmata 5–7-nervia, exaristata, marginibus in parte inferiore dense vilosa; palea lemma aequans, tenuis, ovata, truncata, nervis minute excurrentibus, marginibus latis dense villosa; caryopsis decidua; stylorum bases persistentes; hilum circulare, depressum; embryo latus ellipticus, caryopsi $\frac{1}{3}$ brevior; styli elongati, stigmatibus plumosis.

Spikelets 3–7-flowered, the rachilla continuous, the florets persistent, crowded, successively smaller; glumes subequal, nearly as long as the florets, spreading, 7–11-nerved, some of the nerves faint; lemmas 5–7-nerved, awnless, densely villous on the margins in the lower half, sometimes also on the internerves; palea as long as or a little longer than the lemma, thin, broad, ovate, the broad margins densely villous with long hairs nearly to the summit, sparsely villous on the back at the base, the apex erose-truncate, the nerves excurrent in short awns; caryopsis readily falling from the floret, elliptic, roughly rectangular in cross section, the style bases persistent as short points; hilum circular, depressed; embryo broad, elliptic, nearly two-thirds the length of the grain; styles elongate with the stigmas plumose on all sides; stamens 3.

Stiff perennial, apparently with long underground stems or rhizomes, relatively short, flat, stiff blades, and narrow, simple panicles of large, pale hairy spikelets.

Ectosperma alexandrae Swallen, sp. nov.

Culmi erecti, rhizomatosi (?), ramis fertilibus et sterilibus praediti; rami steriles internodiis breviibus nodis lanato-villosis et foliis densis instructi; rami fertiles graciliores, internodiis superioribus elongatis; vaginae dense ciliatae in ore et collo villosae vel eae remorum fertilium subglabrae; ligula 1 mm. longa, dense ciliata; laminae 4–14 cm longae, 3–6 mm latae, acuminatae, nervosae, glabrae, vel supra scaberulae; paniculae 4–10 cm longae, ramis brevibus, appressis, 1–3-spiculatis; spiculae 1–1.5 cm longae; glumae 9–14 mm longae, acuminatae, glabrae; lemma primum 8–9 mm longum, acutum vel mucronatum; caryopsis 4 mm longa, 2 mm lata, fusca; antherae 3.5 mm longae.

Culms erect with sterile and fertile branches; sterile branches stout with short internodes, lanate-villous nodes, and crowded leaves, the fertile ones more slender, at least the upper internodes elongate; sheaths rounded, densely ciliate, villous at the throat and on the collar, or those of the flowering branches nearly glabrous; ligule 1 mm long, densely ciliate; blades 4–14 cm long, 3–6 mm wide, acuminate, strongly nerved, glabrous, or scaberulous on the upper surface; panicles 4–10 cm long, the branches short, appressed, bearing 1–3 spikelets; spikelets 1–1.5 cm long, nearly as wide; glumes 9–14 mm long, acuminate, glabrous; first lemma 8 mm long, acute or mucronate; caryopsis 4 mm long, 2 mm wide, brown; anthers 3.5 mm long.

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received October 28, 1949.

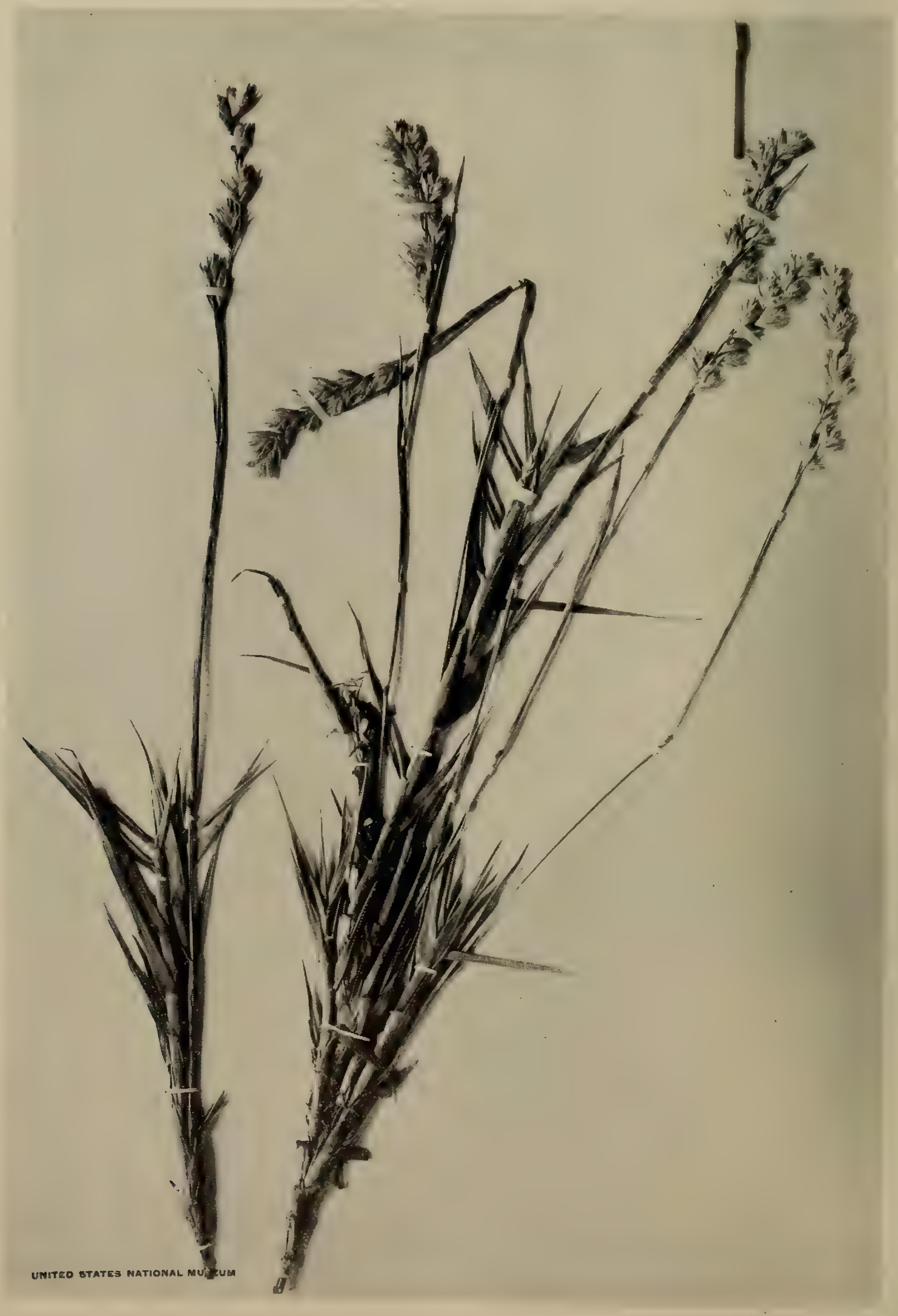


Fig. 1.—*Ectosperma alexandrae* Swallen, gen. et sp. nov.

Type in the U. S. National Herbarium, no. 1963637, collected on lower slopes of big sand hill, Eureka Valley, Inyo County, California, alt. 3,050 feet, May 24, 1949, by Annie M. Alexander and Louise Kellogg (no. 5655).

Regarding the locality Miss Alexander writes: "The sand hill stands over 600 feet higher than the floor of the valley and is a ghostly looking mound seen from a distance. The dense tussocks of the coarse grass, scattered here and there, were growing for a short distance up the north slope . . . the roots were deeply imbedded in the sand."

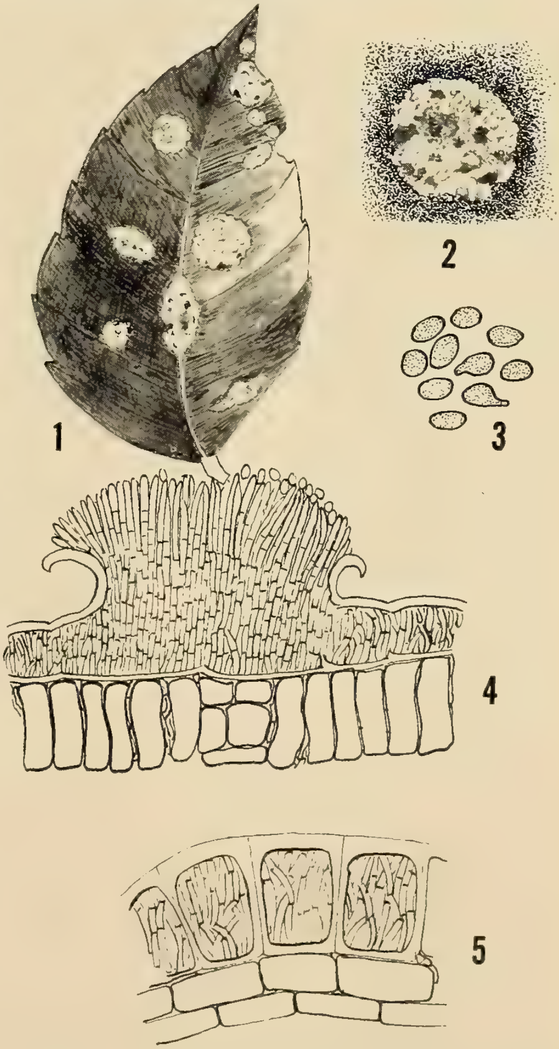
This genus belongs to the tribe Festuceae, although the glumes are nearly as long as the spikelet, which might indicate some affinity with the Aveneae. The characters are so distinctive that it is difficult to determine its actual relationship in the tribe. The appearance of the spikelets suggests *Tridens*, but the characters are completely different.

MYCOLOGY.—Elsinoë viticola *from India.*[1] M. J. Thirumalachar, Hindu University, Benares, India. (Communicated by Anna E. Jenkins.)

During the course of the studies on spot anthracnoses in Mysore, South India, collections were made on *Tetrastigma sulcatum* Gamb. near Kemmangundi at an altitude of 4,800 feet above sea level. *T. sulcatum* is a climbing shrub belonging to the Vitaceae developing pedately compound leaves. The infection spots were noticed on the leaves in the form of circular patches. A cursory study indicated that the fungus was identical with *Elsinoë viticola* Racib. described by Raciborski (1900) from Java on *Tetrastigma coriaceum* (= *Vitis coriacea*), an account of which is presented by Bitancourt and Jenkins (1943).

The infection patches on the lamina of *Tetrastigma sulcatum* are at first chalky white with a corrugated surface. They are circular with sinuous outline, slightly more elevated than the leaf surface and coalescing with one another when in close juxtaposition. Some of the infection patches involving the midrib or the veinlets are more linear or elongated in outline, showing a tendency to spread in the same direction as the veins (Fig. 1). In older stages the infection patches gradually turn grayish brown with islands of black patches (Fig. 2). Raciborski described the infection patches bearing the ascomata of *E. viticola* as being chocolate-brown in color, and Arnaud (1925) described it as superficially resembling the patches of the parasitic alga *Cephaleuros virescens*.

Sections through the young infection indicated the *Sphaceloma* stage of the fungus, which is so far unknown. The initials of the acervuli are formed by the grouping of the



Figs. 1–5.—1, Leaflet of *Tetrastigma sulcatum* showing infection spots of *Elsinoë viticola*, about three-fourths natural size; 2, enlarged view of the infection spot, × 2¼; 3, conidia, × 750; 4, acervulus, × 300; 5, development of sori initials within the epidermis, × 300.

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[1] Received October 7, 1949.

hyphal strands within the epidermis (Fig. 5). Several epidermal cells in a row are involved and a large stroma is formed. These epidermal cells enlarge in size and very soon the upper wall ruptures exposing the conidial stroma (Fig. 4). The conidia (Fig. 3) are produced in abundance acrogenously and these are ovate to spherical, thin-walled, hyaline, measuring 4.5–6 by 4–4.5μ.

The infection patch presents a whitish appearance when the conidia are abundant. As it turns grayish white with black patches, no more conidia can be observed and the stroma becomes large and pulvinate. Though the material was immature early indications of the development of asci were seen in few cases, and further studies are being made to study the ascigerous stage.

As already reviewed by Bitancourt and Jenkins (1943), *Elsinoë viticola* was described by Raciborski from Java and has so far not been collected again in the same or any other locality in spite of repeated search. The type collection of *E. viticola* has been critically examined by Arnaud (1925) and Bitancourt and Jenkins (1943), but on the particular material sectioned all failed to notice any ascigerous stage. Our knowledge of the ascus and ascospores is based therefore on the descriptions given by Raciborski. In the sections through the stroma of *E. viticola* collected by Raciborski, Bitancourt and Jenkins found other saprophytes such as *Phyllosticta* sp., and only hyaline hyphae typical of *Elsinoë* could be made out. *Sphaceloma* stage of the fungus was so far unknown.

The present collection of the fungus on *Tetrastigma sulcatum* from Mysore is the first record to be made outside the type locality in Java. It is also of interest because attempts to recollect the fungus in the type locality since Raciborski's record of it have been unsuccessful (cf. Bitancourt and Jenkins, 1943). Another Elsinoaceae on Vitaceae described from the Eastern Hemisphere is *Elsinoë cissi* Jenkins and Bitancourt (1946) on *Cissus* sp. from Uganda.

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Raciborski, M. *Parasitische Algen und Pilze Javas* **1**: 39 pp.; **2**: 46 pp. Batavia, 1900.

ZOOLOGY.—*A revision of some Actiniaria described by A. E. Verrill.*[1] Oskar Carlgren, Zoological Institution, Lund, Sweden. (Communicated by Waldo L. Schmitt.)

Through the kindness of the Smithsonian Institution and the American Museum of Natural History, I have been able to revise certain species of Actiniaria described by Verrill. Except for *Sagartia leucolena*, all specimens examined were identified by him.

Edwardsia sulcata Verrill

In 1864 (p. 29) Verrill described a species, *Edwardsia sulcata*, the body of which was provided with 12 distinct longitudinal furrows. Andres (1883, p. 317) referred it to the genus *Halcampa*. The presence of the 12 furrows indicates that there may have been 12 mesenteries the whole length of the body. Taken for granted that the description made by Verrill is correct, his species can not be ranged in the genus *Edwardsia*. The holotype is probably lost, but in the collection of the Smithsonian Institution there is a specimen labeled "*Edwardsia sulcata?* Gloucester Mass. Verrill id." [identified]. This specimen is an *Edwardsia* with well-developed physa and eight deep, longitudinal furrows. The nemathybomes are collected in the middle line between the furrows but fairly irregularly in each compartment. It is probable that this displacement is caused by the very strong contraction of the body, but in any case the nemathybomes are apparently not scattered. I counted 14 tentacles, and there are probably never more than 16. The retractors (Fig. 1*a*) are strong, rather restricted with about 20 folds, several of them branched. The parietal muscles (Fig. 1*b*) are strong, though their distribution on the body wall is impossible to determine owing to the strong contraction and poor preservation of the specimen. The

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[1] Received June 6, 1949.

nematocysts of the nemathybomes are partly 84.6–104.3 by about 7μ, partly 52.2–67.7 by 4.2μ; those of the tentacles 21–26.8 by 2.8–3.5μ (basitrichs); those of the filaments partly 24–28.2 by 4.5–7μ (microbasic *p*-mastigophors), partly 19.7–22.6 (25.4) by 2.5–2.8 (3.5)μ (basitrichs).

Drillactis pallida (Verrill)

Edwardsia pallida Verrill, 1879, p. 198.
Halcampa pallida (Verrill) Andres, 1883, p. 317.
Drillactis pallida (Verrill) Verrill, 1922, p. 133G, pl. 21, figs. 4, 4a.

Unfortunately the cotype examined by me is rather badly preserved. The actinopharynx is everted and the tentacles pressed together, and therefore it is very difficult to decide whether the smaller tentacles are situated inside the larger or vice versa. I have made cross sections of the lower and upper part of the very long body. There are probably no nemathybomes. Since the mesenteries are arranged as in *Edwardsia*, the microcnemes are present only in the uppermost part of the body. Fig. 2 shows sections of a macrocnema (*a*) and of a parietal muscle (*b*) in the upper region of the body. The muscle folds of the retractor are few, the outer and inner branched; the parietal muscle is fan-shaped, weak, its distribution on the body wall considerable. In the lower part of the body the retractors of the directives are weaker than those of the other macrocnemes. The nematocysts of the column are 8.5–14 by about 1.5μ (basitrichs); those of the tentacles 14–19 by 2–2.5μ (basitrichs); those of the actinopharynx partly 10–12.7 by 2–2.5μ often a little curved, partly 17–22.6 by 2.5–3 (3.5)μ (both basitrichs); those of the filaments partly 10–14 by 2.2–2.8μ (basitrichs), partly 8.5–13 by 3.5μ (probably microbasic *p*-mastigophors—the filaments are badly macerated).

The genus is certainly nearly related to *Nematostella*, but an examination of fresh material is necessary in order to clear up their relation to each other. It is not identical with *Milne-Edwardsia akkeshi* Uchida, a species that may be referred to a new genus, *Metedwardsia* (Carlgren, 1947, p. 1).

Cladactella manni (Verrill)

Bunodactis manni Verrill, 1899c, p. 218.
Tealiopsis manni (Verrill), Verrill, 1922, p. 110G.
Cladactella manni (Verrill), Verrill, 1928, p. 22, fig. 3, a, c, pl. 4, fig. c.

I have examined a specimen, certainly the same one of which a photo is reproduced on plate 4c of Verrill's paper of 1928. Verrill (1928, p. 22) has given a good description of the exterior and some notes about the inner organization. His statement that the species is devoid of a sphincter is, however, erroneous; the species has a well-developed diffuse sphincter (Fig. 3*a*). The longitudinal muscles of the tentacles and the radial muscles of the oral disc (Fig. 3*b*) are ectodermal. There are considerably more mesenteries at the base than at the margin. The retractors of the mesenteries are very weak, forming low folds in the inner parts of the mesenteries. The parietobasilar muscles form a distinct projection on the stronger mesenteries. The nematocysts of the vesicles are 15.5–18.3 by 2.5–3μ (basitrichs); those of the tentacles 17–21 by 2.5–2.8μ (basitrichs); those of the actinopharynx 24–28 by 2.5–2.8μ (basitrichs); those of the filaments partly 19.7–28.2 by 3.5–4.2μ (basitrichs), partly 15.5–18.3 by 3.5–4.2μ (microbasic *p*-mastigophors).

The genus *Cladactella* may be characterized as follows: Pedal disc broad. Column cylindrical, entirely covered with round or elliptical vesicles very closely set. Fosse rather shallow. Sphincter well developed, diffuse, rather broad. No marginal spherules, no pseudospherules. Tentacles up to about 96, of moderate length, conical, imperfectly retractile. Longitudinal muscles of tentacles and radial muscles of oral disc ectodermal. Two well-developed siphonoglyphs and two pairs of directives. Numerous perfect pairs of mesenteries. Considerably more mesenteries at the base than at the margin. Retractors diffuse, very weak, parietobasilar muscles well developed. Distribution of the gonads imperfectly known but they are seemingly borne on the imperfect mesenteries and on many of the perfect ones. Cnidom: spirocysts, basitrichs, and microbasic *p*-mastigophors.

The genus is nearly related to *Phlyctenactis* (*Cystiactis*), but that genus has mesogloeal muscles in the tentacles and oral disc.

Diadumene leucolena (Verrill)

Sagartia leucolena Verrill, 1866, p. 366; 1873, p. 329, pl. 38, fig. 284; 1898, p. 495; 1899c, p. 208, fig. 29.
Cylista leucolena (Verrill) Andres, 1883, p. 365; Parker, 1900, p. 755, fig. 17; Hargitt, 1914, p. 243, pl. 43, fig. 8, pl. 44, fig. 11.

Two specimens collected by Hargitt and examined by me are undoubtedly *Sagartia leucolena* Verrill. I have sectioned parts of a specimen and examined the nematocysts. The species is, however, no *Sagartia* but a *Diadumene*. The column is indistinctly divisible into a longer scapus and a shorter capitulum. There is no sphincter. The tentacles are divisible into catch tentacles and common ones. I cannot decide the number of the former, because they are not distinctly distinguished from the latter, but they are histologically differentiated inasmuch as their tips are provided with the characteristic nematocysts. According to Hargitt the inner tentacles move in the same characteristic manner as those of *Diadumene cincta* (Carlgren, 1929, p. 110). Hargitt writes (1914, p. 243–244), "It was not unusual to find at certain times that one or even several of the tentacles of the inner series might become more or less specialized at times, apparently serving as tactile organs, being greatly extended and vigorously vibrated in various directions." The longitudinal muscles of tentacles are ectodermal. There are, as in Hargitt's specimen, six pairs of perfect mesenteries typically arranged. The retractors (Fig. 4) of the perfect mesenteries are rather strong, the parietobasilar muscles weak. There are more mesenteries distally than proximally. The nematocysts of the column are partly 12.7–19 by about 2μ (basitrichs), partly 12.7–19.7 by 3.5–4.2μ (microbasic amastigophors); those of the tips of the catch tentacles partly 22.6–28.2 by 6.3–7μ (atrichs, common) partly 17.6–24.7 by 3–4.2μ (holotrichs, common), partly 19.7–26.2 by 4.5μ (*p*-mastigophors or amastigophors); those of the outer tentacles partly 15.5–18.3 by 2–2.8μ (basitrichs), partly 21–24 by 4–4.5μ (probably *p*-mastigophors); those of the actinopharynx partly 14.8–18.3 by about 2μ (basitrichs), partly 21–24 by 3.5–4.5μ (microbasic *p*-mastigophors); those of the filaments partly 8.5–14.1 by 3.5–4μ (*p*-mastigophors), partly 24–28.2 by 4.2–5μ (microbasic amastigophors); those of the acontia partly 26.8–39.5 (commonly 36.5–38) by 7–8.5μ (microbasic *p*-mastigophors), partly 13–16.2 by about 1.5μ (basitrichs). I have not found any macrobasic amastigophors in the few outer tentacles examined, but this is not significant since these nematocysts are rare and do not occur in all common tentacles of *Diadumene cincta*. An examination of a multitude of tentacles may probably show their existence in *leucolena*.

Sagartia spongicola Verrill

Sagartia spongicola Verrill, 1883, p. 47, pl. 6, fig. 3; 1885, p. 534, pl. 7, fig. 200; McMurrich, 1898, p. 238, pl. 2, figs. 3, 4.

I have examined three specimens from Marthas Vineyard. All show an irregular arrangement of the mesenteries indicating that the species may propagate asexually. In two specimens there are nine pairs of perfect mesenteries among which four pairs of directives arranged d.1, d.1, d.1, d.1.1; in the third six perfect pairs, three directives and alternating with these three common pairs. The retractors of the perfect mesenteries are very strong, often circumscribed, sometimes the retractors belonging to the same pair have a somewhat different appearance (Fig. 5*b*). The parietobasilar muscles are well developed, forming a distinct projection on the mesenteries. The imperfect mesenteries are weak as shown in Fig. 5*c*, representing a mesentery of the second cycle from the same slide as the retractors. Probably these mesenteries lack filaments, but owing to the bad preservation of the specimens it is difficult to say if it is really so. The sphincter (Fig. 5*a*) is not strong, showing a distinct tendency to transverse stratification. The longitudinal muscles of the tentacles are ectodermal. The nematocysts of the column are partly 10–12.7 by 1.5–2.2μ (basitrichs), partly 19.7–28.2 by 2.8–3.5μ, partly 31–39 by 4.2–5.6μ (both probably basitrichs). The identification, however, of the nematocysts is not sure because they are very opaque. Moreover there are nematocysts of uncertain type 17–21 by about 4.2μ somewhat broader in their basal end; those of the tentacles 24–28.9 by 3–3.5μ (basitrichs); those of the actinopharynx partly 26.8–32.4 by 2.8–3.5μ (basitrichs), partly 15.5–22.6 by 4.2μ (microbasic *p*-mastigophors); those of the filaments partly 12.7–16.9 by 2.2–2.5μ (basitrichs), partly (12.7) 15.5–19.7 by 3.5–4.2μ (microbasic *p*-mastigophors); those of the acontia 33.8–39.5 by 3–4μ (basitrichs). Already Verrill's statement (1883) that "there are a few small, pit-like openings on the sides, which appear to be pores (cinclidae)" and that "some specimens show small verrucae [papillae] near the summit" indicates that the species may belong to another genus than *Sagartia*. The species is a hormatiid. As the tentacles seem to be some more numerous, or in any case not fewer than the mesenteries at the base, the species may be a *Stephanauge*, though it differs from other known species of the genus inasmuch as it has

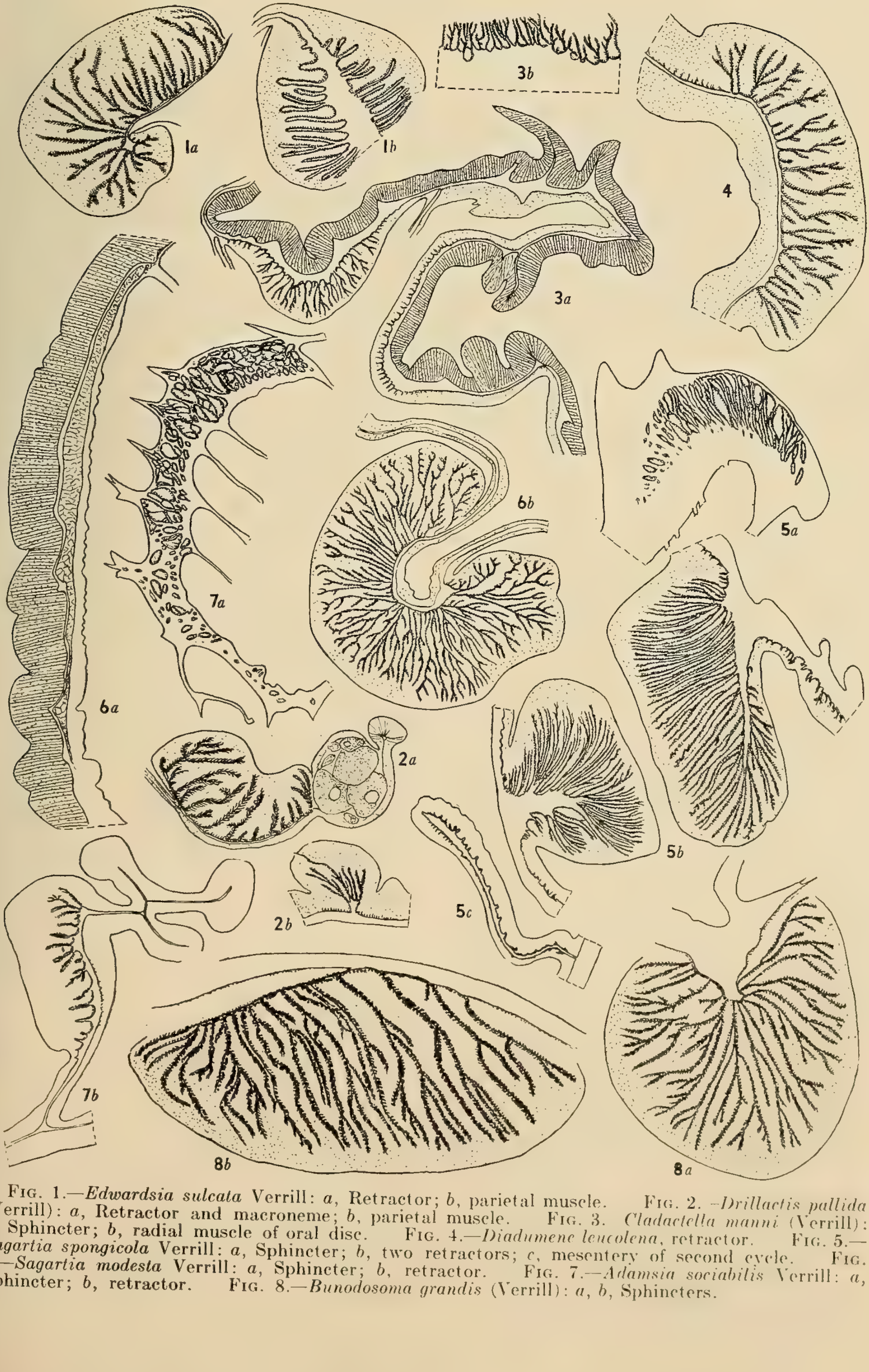

Fig. 1.—*Edwardsia sulcata* Verrill: *a*, Retractor; *b*, parietal muscle. Fig. 2.—*Drillactis pallida* (Verrill): *a*, Retractor and macroneme; *b*, parietal muscle. Fig. 3. *Cladactella manni* (Verrill): *a*, Sphincter; *b*, radial muscle of oral disc. Fig. 4.—*Diadumene leucolena*, retractor. Fig. 5.—*Sagartia spongicola* Verrill: *a*, Sphincter; *b*, two retractors; *c*, mesentery of second cycle. Fig. 6.—*Sagartia modesta* Verrill: *a*, Sphincter; *b*, retractor. Fig. 7.—*Adamsia sociabilis* Verrill: *a*, Sphincter; *b*, retractor. Fig. 8.—*Bunodosoma grandis* (Verrill): *a*, *b*, Sphincters.

considerably stronger retractors, weaker sphincter, and an irregular arrangement of the mesenteries. Verrill (1897) has examined seven specimens of this species. The mesenteries of two specimens show a hexamerous arrangement, those of two other specimens are arranged on a heptamerous plan and three specimens on an octamerous. The directives are two but irregularly set in one specimen, three in five specimens, and four in one specimen. This variability is certainly joined with asexual propagation.

McMurrich (1898, p. 238) gave considerable information as to the anatomy of this species, but he was not sure about its systematic position.

Sagartia modesta Verrill

Sagartia modesta Verrill, 1866, p. 337; 1873, p. 330, 738; 1899b, p. 146, fig. 19; Andres, 1883, p. 193; Parker, 1900, p. 755, fig. 16; Hargitt, 1914, p. 240, pl. 42, figs. 5, 6, pl. 43, fig. 7.

I have examined two specimens from Newport, R. I., of which one is expanded and about 5 cm long and 2 cm broad, and the other strongly contracted. The pedal disc is well developed. The smooth column is probably divisible into a thicker scapus and a thinner short capitulum. Verrill's note also indicates such a division. He says: "When partly contracted, a distinct fold of the surface near the upper margin sometimes projects above the disc." The uppermost part of the column is also considerably thinner than the other parts. The margin is tentaculate. The mesogloeal sphincter (Fig. 6*a*) forms small meshes and occupies most of the mesogloea. It is situated nearer the ectoderm than the endoderm. On slides it seems fairly well developed but in relation to the length of the body it is weak and occupies only about one-seventieth of the length of the body in the expanded specimen. I have more closely examined the larger specimen. Owing to the strong contraction of the tentacles, it is very difficult to count them, but it seems to me that there is about the same number of tentacles and mesenteries at the base, or that the tentacles are somewhat more numerous. There are 42 pairs of mesenteries present at the base; about 2 cm from the margin only 51 mesenteries (6 + 6 + 12 + 1½ pairs). Apparently the development of mesenteries takes place about simultaneously from the margin and from the limbus. There are two pairs of directives, the two first cycles of mesenteries are perfect (as indicated by the contracted specimen). The retractors are present only on the perfect mesenteries. Those on the mesenteries of the first cycle (Fig. 6*b*) reach almost to the base, those of the second cycle disappear about 2 cm from the margin. The other mesenteries are very weak. The perfect mesenteries are fertile. The nematocysts of the column are 10–11.5 by 2.5μ (basitrichs, rare); those of the tentacles 12.7–17 by 2–2.5μ (basitrichs); those of the actinopharynx partly 21–24 by about 2.8μ (basitrichs), partly 21–25 by 3.5–4.5μ (microbasic *p*-mastigophors); those of the filaments partly 15.5–24 by 2.2–2.5μ (basitrichs), partly 21–24 by 8.2μ (microbasic *p*-mastigophors); those of the acontia partly 14–19.7 by about 2.5μ (basitrichs), partly 26.8–33.8 by 4–5.5μ (microbasic *p*-mastigophors or amastigophors).

The position of this species is difficult to decide. Several of the larger nematocysts in the acontia are exploded, but all shafts seem to be wholly destroyed. The shaft of the unexploded capsules is about three-fourths of the length of the capsules, which indicates that the capsules are microbasic *p*-mastigophors. But the amastigophors may rarely have a rather short shaft. Thus, I can not say if these capsules are *p*-mastigophors or amastigophors. The weak sphincter, the division of the column seemingly into a scapus and capitulum make it likely that the species is an Aiptasiid but in such a case it can not be referred to any genus previously known. Verrill who gives only a figure of it, 1899 (p. 146) calls it *Sagartia* (*Psammactis*) *modesta* but without any diagnosis of the new genus. On the other hand, if the capsules are amastigophors, which is hardly acceptable, the species may go to *Actinothoë*.

Adamsia sociabilis Verrill

Adamsia sociabilis Verrill, 1882, p. 225, 314, 315; 1883, p. 45, pl. 8, figs. 2, 3; 1885, p. 534, pl. 8, fig. 26.

Several specimens of this species are examined. Unfortunately they usually are very contracted, the interior is badly preserved and the filaments and reproductive organs are loose from the mesenteries. Owing to that, it was impossible to find any acontia. The sphincter is mesogloeal and well developed (Fig. 7*a*); the retractors of the stronger mesenteries consist of a few but rather high folds (Fig. 7*b*). The nematocysts of the column are 19.7–25.4 by (3.5) 4.2μ (basitrichs); those of the tentacles 9.2–15.5 by 2.5–2.8μ (basitrichs); those of the actinopharynx partly 19.7–25.4 by about 3μ (basitrichs); partly about 14 by 4μ, rare (microbasic *p*-mastigophors); those of the filaments partly 11.3–14.8 by 2.2–2.5μ (basitrichs), partly 11.3–13.4 by 3.5–4.2μ (microbasic *p*-mastigophors). Possibly the species is an *Adamsia*.

Bunodosoma grandis (Verrill)

Cladactis grandis Verrill, 1869, p. 472.
Phymactis grandis (Verrill) Stephenson, 1922, p. 285.
Eucladactis grandis (Verrill) Verrill, 1899a, p. 49.

I have examined several individuals from the Pearl Islands. The specimens are of very different size from 0.3 by 0.4 cm up to 3 by 4 cm. The projections of the column are rather thinly set in the smallest specimens, but in individuals of a height and breadth of 1 cm they stay extraordinarily close. Although all their ectoderm is fallen away, so that I can not give any information of its nematocysts, there is no doubt that we have to do with vesicles as they are not adhesive. They are narrow and rather long and show the appearance given by Verrill (1899, fig. 14, a–c). The fosse is well developed, the sphincter rather weak, circumscribed. I have in figures 8*a*, *b*, drawn the sphincter of two smaller individuals (1.5 broad and 0.8–1 cm high). As the ectoderm of the vesicles also at the margin is lost it was impossible to decide whether marginals are present, but in the fosse of two examined specimens the ectoderm is partly preserved. Here I have found numerous nematocysts undoubtedly atrichs. Thus the species is a *Bunodosoma*. The retractors are broad, bandlike, forming high folds. The parietobasilar muscles are situated on a shelf. The nematocysts of the marginal spherules are 35.2–45.1 by 4.2–5μ (atrichs); those of the tentacles 22.6–25.4 by 3μ (basitrichs); those of the actinopharynx 26.1–29.6 by 3.5–4μ, very numerous (basitrichs); those of the filaments partly 21.1–25.4 by 4.2–4.5μ (microbasic *p*-mastigophors), partly 13.4–17 by about 2.8μ (basitrichs).

The species is neither identical with a specimen from the Gulf of California nor with any other species of *Bunodosoma*, which all have larger vesicles. The number of tentacles in *grandis* is considerably greater than in other species of the genus.

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PROCEEDINGS OF THE ACADEMY

432d Meeting of Board of Managers

The 432d meeting of the Board of Managers, held in the Cosmos Club, November 14, 1949, was called to order at 8:15 p.m. by the President, F. H. H. Roberts, Jr. Others present were: H. S. Rappleye, N. R. Smith, Alan Stone, W. W. Diehl, F. M. Defandorf, W. N. Fenton, W. F. Foshag, F. A. Weiss, W. A. Dayton, Margaret Pittman, H. W. Hemple, O. B. French, F. M. Setzler, and, by invitation, H. E. McComb, J. L. Shereshefsky, and F. C. Kracek.

The President announced the appointment of the following to the Committee for the Academy Journal: L. V. Judson (chairman), W. N. Fenton, F. C. Kracek, Paul H. Oehser, J. A. Stevenson, Alan Stone, and H. S. Rappleye (ex-officio).

The Committee on Membership submitted the names of six individuals for resident membership in the Academy and five for nonresident.

The Chairman of the Committee on Grants-in Aid for Research, Dr. Shereshefsky, reported as follows:

> Members of the Committee on Grants-in-Aid have unanimously recommended that $150 be granted to Edward C. Raney, associate professor of zoology and fishery biology of Cornell University, to assist him in a study of the distribution of the fishes of Virginia. Of this sum it is estimated that $90 will be used in drafting, engraving, and printing of a stream map of Virginia and the remainder for services in plotting the distribution of over 150 species of fishes found in the State.
>
> The Committee also recommends a grant of $250 to Dr. Angus M. Griffin and Miss Jeanne C. Moan, both of the department of bacteriology, School of Medicine, George Washington University, to assist them in obtaining the necessary materials for the completion of a study of induced variations in the group of coliform organisms. The applicants state that this grant will enable them to repeat some preliminary observations on the intestine type *Escherichia coli* and the *Aerobacter aerogenes*, and also to complete this study.

The Chairman called attention to the fact that the Academy had at its disposal $596.50. In subtracting the recommended grants from this amount, there will remain a balance of $196.50.

The Board unanimously accepted the recommendations made by the Committee.

The Nominating Committee, consisting of the Vice-Presidents of the Academy, reported that it had met at the Cosmos Club on October 17, 1949, Francis E. Johnston, presiding. Others present were: W. N. Fenton, F. D. Rossini, J. B. Reeside, Jr., F. A. Weiss, C. A. Betts, F. B. Silsbee, R. S. Dill, A. O. Foster, H. W. Hemple, H. G. Dorsey, O. B. French. F. M. Setzler acted as Secretary but took no part in the balloting. The nominees selected for the offices to be filled by balloting of the membership in December were as follows:

For President-Elect	Nathan R. Smith
For Secretary	Frank M. Setzler
For Treasurer	Howard S. Rappleye

For Board of Managers to serve January 1950 to January 1953 (two to be elected)—Howard P. Barss, Clifford A. Betts, Harold E. McComb, A. T. McPherson.

The Secretary reported the following deaths: Sigurd Orla-Jensen, Royal Technical College, Copenhagen, Denmark, on June 24, 1949 (honorary, elected November 8, 1924); George Tully Vaughan, Washington, D. C., on April 26, 1948 (elected January 17, 1901; on retired list February 15, 1943); William J. Humphreys, formerly of the Weather Bureau, on November 11, 1949 (elected May 17, 1906; on retired list December 31, 1935).

The President reported that, as recommended in the report of the Committee on Policy and Planning presented to the Board on September 19, 1949, he had met with the Committee on Membership to discuss various problems in connection with increasing membership in the Academy. He indicated the desirability of appointing subcommittees on membership in various Government agencies. It was pointed out that the Committee on Membership should serve primarily in the capacity of passing on the qualifications of the applications submitted to them rather than soliciting new members. The present Committee on Membership would favor such subcommittees. The question of preparing specific qualifications for membership was discussed at some length. However, the Board did not deem it advisable to establish such specific qualifications. A motion was approved extending a vote of confidence to the present Committee on Membership and extending to them a vote of thanks. The Board also approved a motion authorizing the President to appoint several subcommittees, consisting of Academy members in the various Government agencies, who were to prepare nominations of qualified scientists and to forward such applications to the Committee on Membership.

The meeting adjourned at 9:25 P.M.

F. M. SETZLER, *Secretary*

Obituary

SAMUEL FREDERICK HILDEBRAND, senior ichthyologist in the Fish and Wildlife Service, died suddenly in Washington on March 16, 1949, of a heart attack, in his sixty-sixth year. He was born on a farm near Stendal, Pike County, Ind., on August 15, 1883. Surviving are his widow, Claudia Chaillaux Hildebrand, whom he married in 1911, two daughters and a son, and three grandchildren.

Hildebrand was the youngest of 12 children. His parents, Herman Henry and Sophia Weitkamp Hildebrand, though originally endowed with but few worldly possessions, were industrious, thrifty farming folk of excellent stock, who emigrated with their two first-born to Indiana from Münster, Germany, in the closing days of the Civil War. One still had to clear most of the land to be able to farm it, and, driven by stern necessity in those early days, the Hildebrands, both old and young, all contributed their bit to the family's welfare. Samuel had his share of chores about the house and in the fields. Before he was old enough to go to school he was counting out three grains to the hill at corn-planting time, and "worming" the 2-acre tobacco patch. Even his first attendance at school at the age of six was delayed two days because of beans that had to be picked. Most of his early schooling was received from a succession of teachers in the proverbial little red one-room schoolhouse.

Before he "graduated" at 17 he had assisted his teacher with classes on a number of occasions and acquired such an interest in learning and scholarship that he attended a summer normal course to qualify for a teacher's license. Without a formal high-school education, for two years he taught, with marked success, higher grade schools not far from his home. On off days he continued farming to add to his earnings as a teacher, in order to finance a start at the State Normal School, later Teachers College, in Terre Haute. The other funds needed were earned by doing odd jobs, waiting tables, promoting a students' boarding club, tutoring in German, and serving as "chief bottle washer" in the biology lab.

His habit of making every minute count, the result of home training and of farming when not attending school, and his ability to do so well the many necessary things a biology lab assistant was called upon to do, brought him to the favorable attention of Seth E. Meek, ichthyologist at the Field Museum in Chicago. His acceptance of an assistantship proffered by Meek in the spring of 1908, a year before he was due to graduate from Normal, marked the beginning of Hildebrand's serious interest in the study of fishes that was to lead to his becoming one of the world's leading ichthyologists. In the course of his two years with the Chicago Museum he assisted Meek as junior author in the preparation of *A synoptic list of fishes known to occur within fifty miles of Chicago*. This was the first published paper in which he had a hand.

He also found time to take certain courses at the University of Chicago, and, with the credits so obtained, he returned early in 1910 to State Normal to complete the requirements for a B.A. degree. This proved a providential move, for during graduation week he made the acquaintance of a fellow Hoosier, Barton Warren Evermann, then chief of the division of scientific inquiry in the Bureau of Fisheries. Hildebrand soon qualified as scientific assistant for a vacancy of which Evermann apprised him, and on October 1, 1910, he entered the service of the Bureau in Washington, D. C. Within the first three months he completed his second published paper, with Evermann as senior author, *On a collection of fishes from the lower Potomac, the entrance of Chesapeake Bay, and from streams flowing into those waters.*

By mid-December he was on his way to Panama with Meek as a participant in the biological survey of the Canal Zone, sponsored by the Smithsonian Institution for the purpose of ascertaining faunal and floral conditions in the area before the construction of the inter-ocean canal seriously began. The ichthyological collections amassed by the two of them during five months of field work were to provide Hildebrand with his major interest for the rest of his life and the material upon which some of his finest published work was based: *The fishes of the fresh waters of Panama* (1916) and *The marine fishes of Panama* (3 vols., 1923, 1925, 1938). Though carrying Meek's name as senior author, these monographic treatises were written wholly by Hildebrand and were almost entirely based on his personal study of the collections carried on in winters spent in Washington when not discharging important responsibilities elsewhere for the Bureau. Meek returned from the second trip to Panama a seriously ill man, and died in 1914 without taking any active part in the preparation of the reports other than the brief preliminary descriptions of several new species of Panamanian fish, of which Hildebrand was also junior author.

During the four years (1914–18) that Hildebrand first served as director of the Fisheries Biological Station at Beaufort, N. C., he initiated an invaluable series of studies of the life histories of fishes from egg to definitive young. One of the earliest published dealt with the top minnow (*Gambusia*), just then coming into notice as a natural enemy of mosquito larvae. Thus, when the Navy took over the Beaufort Station in 1918 following this country's entrance into World War I, it was quite the logical thing for Hildebrand to undertake a practical demonstration of the value of the top minnows in malarial mosquito control, under the auspices of the U. S. Public Health Service in the extra-cantonment zone at Camp Hancock, Augusta, Ga. Though this experiment was brought to a close with the end of the war, the results exceeded all expectations. Therefore, the investigation of which that demonstration was a part was resumed as soon as the Public Health Service could again obtain Hildebrand's services. This was early in 1920, after he had completed a 15-month assignment as director of the newly authorized Fisheries Biological Station at Key West. The application of Hildebrand's talents as investigator and consultant to the problem proved so successful that some of the series of significant Public Health bulletins and other papers that he wrote on top minnows, their habits, distribution, and propagation, and their relation to mosquito control were translated into several foreign languages.

Shortly after his return to the Bureau late in 1924 he conducted a 3-month survey of the streams and lakes of the Republic of El Salvador, with a view to the development of local fisheries, their conservation, and the possibilities of the artificial culture of native and introduced species. Although the systematic account of the fishes collected appeared the next year, the publication of the essential results of the survey in Spanish was delayed by the Salvadoran Government until 1936.

The six years following Hildebrand's return in 1925 to Beaufort as director were exceedingly busy ones. It was a period of substantial improvement and expansion of plant and personnel. Such time as could be spared from administrative duties was given over to the continuation of his interrupted life histories of fishes. The life histories of some 44 species were largely completed and published upon in the course of his successive residences at Beaufort. A large series of experiments in diamondback-terrapin culture carried out during the second tour of duty at Beaufort satisfactorily demonstrated that terrapins could be grown in captivity as readily as chickens. His interest in their culture led also to several publications on their biology and that of marine turtles as well.

The first spring after he returned to the directorship at Beaufort, the University of Georgia asked Hildebrand to deliver a 2-week series of lectures on mosquito and malaria control to the Public Health Department of the Medical School. The enthusiastic reception accorded these lectures induced the university to confer the degree doctor of public health on him in recognition of his notable achievements and publications in the field of public health.

In 1931 he returned permanently to Washington, where by choice and with the permission of his Bureau he devoted himself almost wholly to systematic ichthyology except for four brief field trips. The first of these, made in 1933, involved nearly three months of travel throughout Mississippi as adviser on fisheries matters to the then newly established State Fish and Game Commission. In 1934 a 2-month investigation of the mountain streams of Puerto Rico was undertaken for the purpose of determining their suitability for supporting trout. At that time he recommended bullhead catfish and bluegill sunfish for the lower reaches of those streams and certain impounded waters. These fish later were successfully introduced. Although the trout themselves would thrive in the streams at higher elevations, the water was subsequently found a little too warm for natural propagation. *An annotated list of the fishes of the fresh waters of Puerto Rico* reported on the collections made during that survey.

In 1935 and again in 1937, Dr. Herbert C. Clark, director of the Gorgas Memorial Laboratory in Panama, invited Hildebrand to revisit the Canal Zone at the time of the dewatering of the locks for cleaning and overhauling. The Gatun or Atlantic side locks were the object of his visit in 1935, and the Pedro Miguel and Miraflores locks at the Pacific end of the canal in 1937. The results of his examination of the locks and the animal life found in them were incorporated in his report on *The Panama Canal as a passage for fishes with lists and remarks on the fishes and invertebrates observed.* On both occasions, besides the material taken from the locks, fish were also extensively collected in all available fresh waters throughout the Isthmus. So much new information was secured that Dr. Hildebrand prepared and published *A new catalogue of the fresh-water fishes of Panama*, which included substantial additions to his and Meek's earlier account. At the time of his death he was actively working on the large series of marine fishes also secured on both of these trips to Panama with a view to a similar critical supplement to *The marine fishes of Panama.*

Desirous of giving over his entire time to ichthyological researches, Hildebrand never sought, and indeed refused, all advancement in government service along administrative lines, for which he was particularly well equipped. In his last 18 years in Washington (1931–49) he published more than half of his purely systematic papers, besides completing a number of reports on biological studies made during the Beaufort years on terrapins and the life histories of fishes. Especially noteworthy among the results of his systematic studies, other than those already referred to, were: *The fishes of Chesapeake Bay*, with William C. Schroeder; *Systematic catalogue of the fishes of Tortugas, Florida, with observations on color, habits, and local distribution*, a careful revision of an unfinished manuscript by the senior author, the late William H. Longley; *An annotated list of salt and brackish water fishes with a new name for a menhaden, found in North Carolina since the publication of 'The fishes of North Carolina' by Hugh M. Smith in 1907; A review of the American anchovies (family Engraulidae)*, regarded by Dr. Hildebrand as his most thorough piece of research in systematic ichthyology; and *A descriptive catalog of the shore fishes of Peru.* As the last-named was being concluded and the supplement to *The marine fishes of Panama* was approaching completion, preliminary work was being undertaken on a companion volume on the fishes of Chile, which would have completed the coverage of the ichthyological shore fauna of the entire west coast of the South American Continent.

In point of number of titles, his bibliography is a modest one, comprising to date 75 titles, exclusive of a number of translations of some of them into foreign languages. It embraces several important fields of scientific interest, to each of which significant original contributions were made. Among these fields the papers are distributed approximately as follows: Systematic ichthyology, 33; life histories of fishes, their biology, food habits, and distribution, 12; biology of terrapins and marine turtles, and their culture, 8; mosquito and malaria control, primarily by means of the top minnow, 10; popular accounts and standard reference-work information concerning fishes, the control and conservation of fisheries in specific areas, official reports on biological station operations, and miscellaneous notes, 12. In addition to the foregoing, there are two manuscripts, one complete on *The herrings and herringlike fishes*, written for inclusion in the *Fishes of the Western North Atlantic*, being sponsored and issued by the Sears Foundation, Yale University; and the other the largely completed supplement to *The marine fishes of Panama.*

Dr. Hildebrand was elected to membership in the Washington Academy of Sciences on December 1, 1939; was a fellow of the American Association for the Advancement of Science; a member of the American Fisheries Society, the American Society of Ichthyologists and Herpetologists, the National Malaria Society, the Biological Society of Washington, and Sigma Xi; and an honorary member of the Panama Canal Natural History Society and the Pacific Sailfish Club. He was frequently consulted by the U. S. Food and Drug Administration and the U. S. Tariff Commission in matters concerning packaged and imported sea foods and fishery products; and he served as a member of the editorial board of the Sears Foundation. At the request of the Navy Department, he furnished most of the names of fishes used to designate submarines during World War II. He was a member of the board of trustees of the Brookland Methodist Church in Washington and for some years secretary-treasurer of the Brookland Citizens' Association.

Though raised in a strictly fundamentalist atmosphere in which the Bible was literally interpreted, Hildebrand was broadminded in his religious beliefs. He believed that what really counted after all was the service rendered one's fellow men, even in the work we do. At one time he entertained the idea of entering the Methodist ministry, as had one of his brothers. On more than one occasion he delivered memorable lay sermons for his church. Sunday school he taught as a young man, and again in his more mature years at Beaufort and in Brookland. In the latter place he conducted a class of young adults. He was an inspiring, much revered and sought-after teacher. It was at a Wednesday evening meeting of this very class that he was fatally stricken.

Altogether too rarely does the world produce men of such substantial achievement, sterling worth, and high character, so truly Christian in every sense of the word, respected and beloved not only by his Sunday-school classes and the fellow members of his church, but by all who ever knew him as a man and scientist.

WALDO L. SCHMITT.[1]

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[1] Although Dr. Hildebrand was an intimate and dear friend of mine since our first meeting in 1910, when we were both appointed to the staff of the old Bureau of Fisheries, these notes are in large part based on an autobiographical sketch that he prepared in 1944. I am indebted to Mrs. Hildebrand for her kind permission to make use of that material as I desired.—W.L.S.

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JOURNAL
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ANTHROPOLOGY.—*Early description of lambdoid cranial deformity incorrectly attributed to the Navaho: Historical note on R. W. Shufeldt, M.D. (1850–1934).*[1]

T. D. STEWART, U. S. National Museum.

At a meeting of the Anthropological Society of Washington on November 2, 1886, Prof. Otis T. Mason read a paper entitled "Head Flattening among the Navajos" for an absentee member.[2] The author of the paper, Robert Wilson Shufeldt, was then with the Army at Fort Wingate on the frontier of New Mexico. To judge by the published version of the paper,[3] it consisted of brief reference to two deformed skulls, together with observations on head deformation in the living Navaho. The two skulls already had been described in separate publications (Shufeldt, 1886a and b) in the Journal of Anatomy and Physiology of London. To the description of the first of these skulls, Sir William Turner, a distinguished anthropometrist and one of the editors, had added a note calling attention to the deformity which Shufeldt had completely overlooked. Thus, perhaps it was Sir William's note that led Shufeldt to make an investigation of head flattening among the living Navaho.

Shufeldt's two papers of 1886 are remarkable for containing some unwarranted, though perhaps understandable, assumptions. First of all, there is inadequate proof that the two skulls were those of Navahos. As Shufeldt did not himself collect the specimens, his identification rests mainly on the statements of his collectors. The first skull, he says, "was collected by a young man on one of their burial grounds upon the hills in the vicinity of Fort Wingate. . ."; the second "was collected in a cañon some 30 miles from Fort Wingate. . . from a lot of graves there found among the rocks. . . . My collector informed me that the Navajos had buried a dozen or more of their dead in the same locality. . ." Although the first statement now suggests the Pueblo mode of burial, the second does indeed suggest the Navaho. The fact that the Navaho were living in the area at the time lent plausibility to both statements. Little had then been published about the Pueblos who had occupied this region at an earlier time, although Bandelier (1892, pp. 343–345) had already examined the ancient ruins about Fort Wingate. Thus the need to differentiate between Navaho and Pueblo was not even considered by Shufeldt.

A second assumption concerns the mode of death exhibited by the first skull. Shufeldt (1886a, p. 426) states that death was caused "by a gun-shot wound of the head." And he goes on to say that—

> The large wound of entrance has pierced the left outer angle of the supraoccipital bone, and destroyed the adjacent mastoidal process of the *pars mastoidea* of the temporal, resulting in a magnificent example of that rare condition, a fracture by *contre coup*, the external appearance of which may be seen upon the right frontal bone of the figures.

Examination of the figures, however, suggests to me that the frontal wound is a

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received October 10, 1949.

[2] See note following item 95 in Shufeldt, 1887, p. 15.

[3] The final publication may represent a completely altered version. In the "Abstract of the Proceedings of the Anthropological Society from Nov. 3, 1885, to May 15, 1888" (p. 364) there is a footnote stating that this paper "will be published in the Annual Report of the Smithsonian Institution for 1886." However, the author's bibliography (Shufeldt, 1887, p. 15) states that this paper had been "accepted as a contribution for the Report of the Bureau of Ethnology." Actual publication was in the Popular Science Monthly of 1891.

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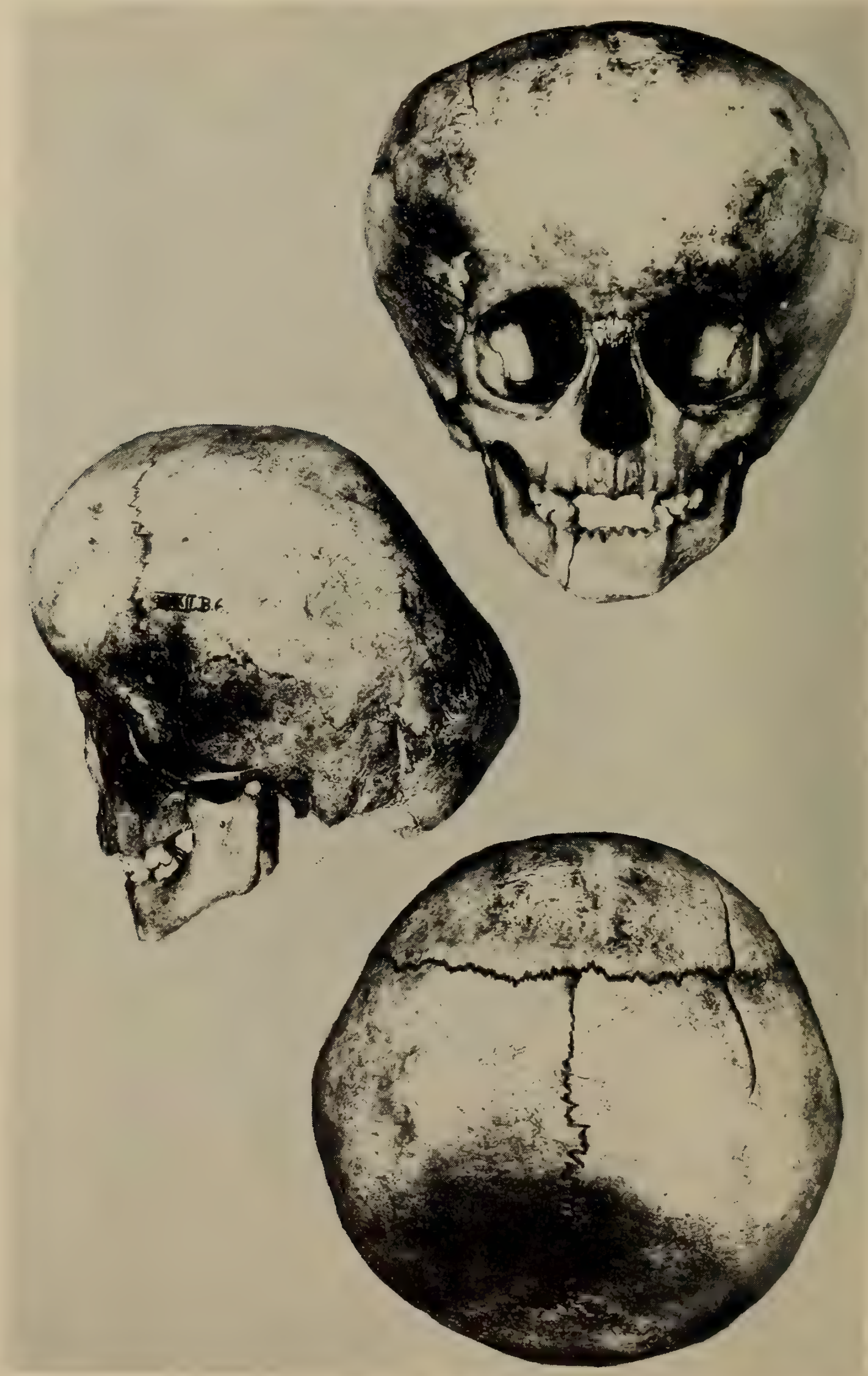

Fig. 1.—Skull XXXII.B.6; child; in Anatomical Museum, University of Edinburgh. Collected near Fort Wingate, N. Mex., and donated by R. W. Shufeldt in 1886. Evidence is presented herewith to show that this is probably not a Navaho, as originally claimed, but a prehistoric Pueblo. Note that extreme lambdoid deformity makes the orientation on the Frankfort horizontal seem unnatural. (Photographs by courtesy of Prof. W. C. Osman Hill.)

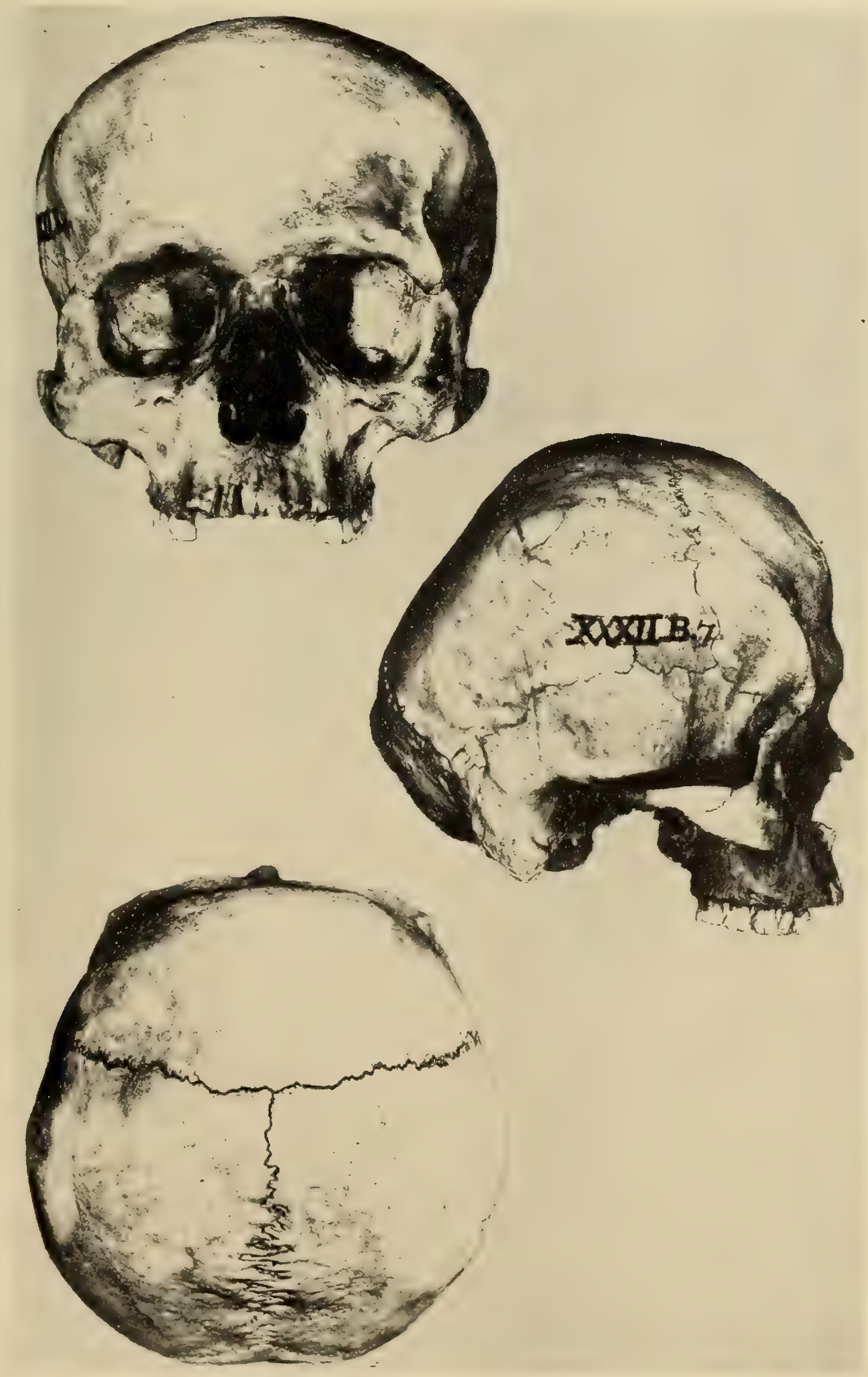

Fig. 2.—Skull XXXII.B.7; adult male; in Anatomical Museum, University of Edinburgh. Collected near Fort Wingate, N. Mex., and donated by R. W. Shufeldt in 1886. Evidence is presented herewith to show that this is probably not a Navaho, as originally claimed, but a prehistoric Pueblo. Note moderate lambdoid deformity. (Photographs by courtesy of Prof. W. C. Osman Hill.)

small depressed fracture such as could result from a blunt object striking the head at this point. The nature of the damage to the left mastoid is not ascertainable from the figures. Of course, a gunshot wound could mean that death had occurred within the historic period and this would support the Navaho attribution. On the other hand, the type of fracture that the figures seem to show could have occurred in prehistoric times.

A third assumption is resorted to by Shufeldt to account both for the extreme deformity in the skulls and for his failure to find more than slight occipital flattening among the living Navaho. His assumption is that they had practiced intentional deformation earlier but had given it up before the time of his observations. Nothing was found in the cradling practice then current to support this idea. Moreover, if such extreme deformity as exhibited in the two skulls was no longer to be encountered among the living, this suggests the lapse of a considerable time interval. If such were the case, then it seems likely that the burial places of these former inhabitants would no longer have been known to the local people.

The case against Shufeldt's tribal attribution required, it seemed to me, a re-examination of the skulls themselves. Otherwise there is nothing upon which to base an opinion, except Shufeldt's obviously imperfect drawings. But first the skulls had to be located. My search for them was aided by Shufeldt's own statement (1886b, p. 66) that the adult skull had been donated to the Anatomical Museum of the University of Edinburgh. An inquiry addressed to Prof. W. C. Osman Hill, of the Department of Anatomy, University of Edinburgh, brought the prompt reply that both skulls are still in their collection. Subsequently he kindly sent the photographs reproduced in Figs. 1 and 2, together with an authoritative opinion on the "gun-shot wound."

Comparison of the photographs with the published drawings reveals, as expected, some defects in the drawings but verifies the nature and extent of the artificial deformity. The designation used today for this kind of deformity is "lambdoid." Our present knowledge of this type of deformity in the Southwest comes entirely from collections of Pueblo skulls. In a recent (1949) summary of the geographical and chronological distribution of lambdoid deformity among the Pueblos, Erik Reed has this to say:

> Artificial lambdoid skull-flattening can be delimited in both time and space—between 700 A.D., or somewhat later, and approximately 1300 A.D.; from the upper Rio Grande [in New Mexico] to the lower Virgin River [in southeastern Nevada] and from the Little Colorado area, including the vicinity of Flagstaff [Arizona], to the northern boundary of the Pueblo domain in Utah and southwestern Colorado. (p. 115.)

Fort Wingate, from the vicinity of which Shufeldt's two skulls came, is within these boundaries. Moreover, as already indicated, it is well established that there are old Pueblo ruins in this vicinity.

On the other hand, it must be admitted that still very little is known about early Navaho skulls. Malcolm (1939) reported finding the burial of an adult male in Chaco Canyon that was "of undoubted Navaho origin but quite old." Donovan Senter, who examined the skull, states that "there was a slight artificial lambdoid deformation" (Malcolm, 1939, ftn. 28, p. 16). I should like to be sure that Senter did not confuse artificial flattening with natural flattening, but unfortunately I have been unable to locate this skull. Nor can I locate other authentically old Navaho skulls. The fact remains, therefore, that Shufeldt's two skulls are about the only evidence that the Navahos practiced lambdoid deformity. From other considerations given herewith this is not very good evidence.

Like the drawings, the photographs do not throw much light on the nature of the damage to the frontal and mastoidal regions of the adult skull. However, Professor Hill was good enough to furnish me with an opinion obtained by his assistant, Dr. Hugh Taylor, from Sir Sydney Smith, professor of forensic medicine at the University of Edinburgh, and the latter's assistant, Dr. Fiddes. In their opinion, writes Dr. Taylor:

> . . the damage done to the frontal area was *not* due to any gunshot wound either by "contre coup" or directly. . . . In addition, they both doubt whether the "large wound of entrance" was caused by a gunshot wound at all. This opinion was based on their knowledge of the known types of apertures made by gunshot wounds. Dr. Fiddes also pointed out that this skull was covered with

"adipocere"—a substance found in skulls which lie buried for some time in soil—except on the edges of this large aperture. From this he concluded that the aperture was probably made either as the skull was being removed from the soil, or after it had been removed.

In the light of these facts, and the developments during the 60-odd years since Shufeldt wrote, the two skulls that he labeled Navaho seem more likely to be Pueblo.[4] The indications that the Navaho did not practice the lambdoid type of deformity exhibited in these skulls, whereas the prehistoric Pueblos around Fort Wingate did, favors a prehistoric dating. In addition, the refuted diagnosis of gunshot wound may likewise mean that these skulls date back to a prehistoric period. Essentially therefore, the tribal identification of these skulls rests upon the statements of untrained collectors.

It is to be hoped that future bibliographers will clarify the nature of these references. Otherwise they will continue to mislead the unwary reader seeking information on the Navaho. Dingwall, for example, who wrote a book (1931) on the world-wide distribution of artificial cranial deformation, has referred therein to Shufeldt's first paper and Turner's note thereon. And the latest special bibliography on the Navaho (Kluckhohn and Spencer, 1940), as well as the foremost general ethnographic bibliography (Murdock, 1941), includes this whole series of references.

In my opinion the main contribution of Shufeldt and Turner in these papers, although admittedly little use has been made of it, was to provide an early description of lambdoid deformity. However, theirs was not the earliest. This honor goes, so far as I can discover, to W. J. Hoffman eight years earlier (1878). The specimen described by Hoffman, usually considered to be a Pueblo, came from the Chaco Canyon, which is around 50 miles northeast of Fort Wingate.

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[4] Because of individual variation, the facial proportions in the adult are not helpful for purposes of tribal distinction.

ETHNOLOGY.—*Bird nomenclature and principles of avian taxonomy of the Blackfeet Indians.*[1]

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The present paper comprises the preliminary results of a program of ethnobiological research now being carried on by the Museum of the Plains Indian among the Blackfeet Indians of Montana. As a field of inquiry, the relationships between man and nature in the Northwestern Plains and the traditional native ideologies built up around its biota offer much to enrich our understanding of the resident Indian cultures. In this study attention is confined to Blackfeet ornithology and, more narrowly, to the nomenclatorial phase of that topic. The rest of the material collected on Blackfeet bird

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[1] Received September 6, 1949.

knowledge, including the economic importance of wildfowl, methods of taking, birds as pets, socioceremonial aspects, and the whole structure of avian folklore, has been set aside for presentation at a later date.

The Piegan, or southernmost Blackfeet tribe, have occupied the short-grass plains of northwestern Montana from as early, at least, as the beginning of the nineteenth century. As Saunders (p. 9) has pointed out, the plains, most of the mountain valleys, and all the lower slopes and canyons of this region are located in the Transition Life Zone. Within this zone the same author (pp. 12–26) has tentatively demarcated a number of faunal associational areas—grasslands, lakes, marshes, thickets, etc.—each with its characteristic assemblage of bird forms. Westward the Hudsonian, Canadian, and Arctic-Alpine Zones at successively higher elevations of the Rockies are distinguished, in turn, by different groups of tree-dwelling species. As a result, the avian life of the Piegan country is both varied and abundant.

The same life-zone pattern can be extended northward into Canada, presumably with slight if any change in faunal types, to include the tribal territories of the Blood and Blackfeet proper. In Alberta and Saskatchewan the plains south of the North Sasketchewan River represent the earliest known hearth of Blackfeet culture (Ewers, p. 9). Throughout the period of their recorded history, the three tribes have resided continuously within the Transition Zone. Their long acquaintance with plains-dwelling bird species is reflected, accordingly, in Blackfeet terminology.

My ornithological notes were collected during the winter and spring of 1948–49 from southern Piegan sources in and about Browning, Mont. Most of the data came from Jim White Calf (WC), age 85; Richard Sanderville (RS), age 83; and Wallace Night Gun (NG), age 76. White Calf was not only versed in native bird lore, but his ownership of the Beaver Bundle made him conversant with ceremonial aspects of the topic.[2] He was acquainted with the names of about 70 species. Sanderville, as the result of a life long interest in Blackfeet culture and history, had accumulated a fund of knowledge on the avian world. He was familiar with the names of about 60 species. Night Gun's knowledge was less extensive, but he proved useful in checking the statements of others. Less frequently and for shorter intervals, the services of Weasel Tail (WT), age about 90, Green Grass Bull (GB), age 86, and Short Face (SF), age 78, were utilized for information on various points. Their knowledge was about equal to Night Gun's. My interpreter was George Bull Child. An opportunity to compare Blood nomenclature with that of the Piegan was presented in the person of Harry Under Mouse (UM), age 58. This informant had grown up on the Blood Reserve, in Canada, and possessed a fair knowledge of the ornithology of that group. From his statements it appears that such differences as may formerly have existed between the two tribes were relatively minor and unimportant.

The procedures employed in identification deserve comment here. Black-and-white and colored bird plates ordinarily utilized for this purpose proved inadequate among elderly Blackfeet, many of whom are illiterate and handicapped by poor vision as well. Another method, supplemented by illustrations (Pearson; Peterson) and verbal descriptions, provided more satisfactory results. It consisted of submitting a series of prepared bird skins[3] to informants for detailed examination and comment.[4] Skins of 107 different species were chosen from the total of 332 known to occur throughout the State. Selection of skins was arbitrary but included representative varieties of the plains and mountains of northwestern Montana, plus a few from adjacent faunal provinces. This material was presented in groups of related species, so that intrafamily comparisons of size, proportion, and color could be made. Omitted for reasons of packing and shipment were specimens of the larger birds, such as the eagle, vulture, swan, ducks, etc. Most of these species were so distinctive, in form or habit, that reliable identification was made in other ways. The disadvantages of this method were the absence of specific behavioral traits (posture, gait, flight, song), upon which native terminology is often based.

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[2] Today (and possibly in earlier days) the greater part of Blackfeet faunal lore is in the possession of certain Medicine Bundle ritualists, who recapitulate the traditional knowledge of their forebears during the formal opening of the bundles.

[3] The prepared bird skins were secured on loan from Washington State Museum, Seattle. The assistance of Dr. Erna Gunther, director, in making available the Museum's ornithological collections is gratefully acknowledged. I am also indebted to Mrs. Martha Flahaut, curator of biology, for advice on points of bird distribution, behavior, and source material.

[4] This procedure conforms with a pre-established pattern of Blackfeet ceremonialism, in which animal and bird skins from certain medicine bundles are handled in ritualistic ways, usually in mimetic dance and song contexts. See Wissler, p. 168 ff.

The scope of the study was widened, historically, by reference to lists of Blackfeet bird names collected over a period of more than a century by various white observers. The earliest known data, consisting of less than a dozen terms, were gathered by the fur trader Alexander Henry (Coues, vol. 2, pp. 534–538), presumably from native sources on the upper Saskatchewan River prior to 1811. Henry's terms, except for one, are recognizable by modern Blackfeet and approximate contemporary referents to the species indicated. A half century later, F. V. Hayden (p. 265), who accompanied several exploring expeditions to the upper Missouri (1854–60), compiled an important list of 35 bird names. In the case of Hayden's material, it is not always possible to equate his English equivalents with those of modern ornithologists. McClintock (1910; 1923), starting in 1896, accumulated a quantity of information on Blackfeet life, which contains scattered references to bird names and bird lore. The most recent material is that recorded in 1910–11 by de Josselin de Jong and Uhlenbeck during the course of their linguistic studies among the Southern Piegan.[5] Data from these different sources provide a rough cross section of Blackfeet nomenclature at various time periods and serve as a comparative check upon modern Reservation knowledge.

The Blackfeet generic term for bird, particularly of the larger species, is *piksí* (Henry: peeksue).[6] The etymology of this word is obscure, but to modern Indians it conveys the sense of "magical" or "wonderful," possibly in reference to avian powers of flight. A comparable designation for the smaller birds is *sistsí*. The latter is frequently, and the former more rarely, combined with different adjectival prefixes to form the names of various species. Possibly both terms are onomatopoeic in origin. A separate term *póksistsi*, "small *sistsí*," is reserved for the less brightly colored varieties, such as the sparrows, etc.

The bird names of the Blackfeet are set forth below. My identifications and terminology are chiefly based upon those listed in Peterson (1941). Where the native term is applied to an entire family rather than a particular species, I have indicated that fact in the use of the scientific term.

Matsiísaipi, "fine charger," loon (Gaviidae). The term refers to the loon's habit of extending and flapping its wings on the water. The Blackfeet interpret this behavior metaphorically, in terms of their war tactics. Some informants (WC; NG) also extend the term to the merganser.

Mikskssístaii, "fine diver"; *apαtsséssika*, "legs grow backward," grebe (Colymbidae). The extreme posterior placement of the grebe's legs is responsible for the latter term. Known locally as helldiver.

Soχkaúkomi, "big throat"; *aiisípissa*, "carries water," white pelican (*Pelecanus erythrorhynchos*). Reference is made to the appearance and alleged function of the capacious throat pouch.

Moχkámi, great blue heron (*Ardea herodias* subsp.). A mimetic term regarded as a close reproduction of the species' low, hoarse croaks. One source (UG, p. 157) defines the word as pelican. Since my informants' descriptions indicate the heron, and other terms exist for the pelican, the former appears to be the bird in question. Confusion exists among many bilingual Blackfeet as to the correct English names for these and other bird species, a situation responsible, I believe, for the above error.

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[5] Uhlenbeck and van Gulick, abbreviated as UG in text reference. The above-noted linguists gathered a considerable number of bird names, which are referred to only if they diverge from my own data.

[6] The system of recording native terms employed by Uhlenbeck and van Gulick (pp. 7–8) is followed in my own text renderings. In general, the vowels and consonants have nearly their continental values, with *α* expressing the *u* sound in English *but*; Greek χ the guttural, nonpalatized fricative; and *x* the palatal voiceless fricative.

Itápksissi natosi, "pointing beak to the sun"; *natoípiksi*, "sacred bird," American bittern (*Botaurus lentiginosus*). The first name is based upon a well-known habit of the bittern. Upon alighting at its nest the bird, according to native belief, points its beak toward the sun and follows its course throughout the day. The latter term represents a later interpretation consonant perhaps with an increasing Blackfeet emphasis upon the Sun as the supreme spiritual power.

Imíχkaii, "going home"; *ksikómaχkaii*, "white going home," swan (Cygninae). Both terms refer to the swan in migrant status. Henry: *omakaiye*.[7]

The ducks and geese are classified as *sée*, a term modern Blackfeet are unable to define. That it had much the same application more than a century ago is evident from Henry's *sahesk*, "goose," and *sahesh* or *sihow*, "duck." The word *sée* is combined in one instance with a prefixed element to form the name for the merganser. The subfamilies of ducks are known generically by the designation *méksikαtsi*, "red feet." Hayden's term for teal duck, *piksikáci*, is probably equivalent. Large ducks (*omaχséksikαtsi*), such as the mallard, are distinguished as such from the smaller varieties (*inakséksikαtsi*), as the teal. I could obtain no further data on differentiation of species.

Ápspini, "white cheeks," Canada goose (*Branta canadensis* subsp.). Hayden: *apspíni*, common wild goose; UG (p. 98) *saiaí, ápspini*, goose.

Iínoχksikanikim, "dark-tipped feathers," snow goose (*Chen* sp.). UG (p. 33) gives this term for brant.

Misée, "hardy *sée*," merganser (Merginae). Hayden: *miésa*, fish duck. Term assigned for reason of the merganser's ability (1) to winter in northern latitudes, or (2) to submerge for long periods. This bird group is confused, terminologically, both with the grebes (WC) and the bitterns (WC).

Píkoki, "scabby head," turkey vulture (*Cathartes aura*). Hayden's term, *sikaí*, is unfamiliar to my informants.[8]

Omaχsapítau, "big eagle," California condor (*Gymnogyps californianus*). Evidence for the occurrence of the condor as a rare, extralimital wanderer in the Browning area is being prepared in a separate paper.

Pítau, eagle, especially the golden eagle (*Aquila chrysaëtos canadensis*). Henry: *peeta*; Hayden: *pitáo*, war eagle. An archaic term. It suggests today the sense of proud or "beautiful." Hayden's *isisúnikim* ["dark speckled feathers"] and *sikitsinaíaks* ["black shin"], black eagle, are both said to refer to the golden eagle in adult plumage.

Ksikixkíni, "white head," bald eagle (*Haliaeetus leucocephalus* subsp.). The *sekakineoa* of McClintock (1910, p. 484) is evidently a phonetic variant transcription.

The hawks are known collectively as *aiinnimaíaks*, "seizers." One source (UG, p. 46) gives this as the name for chicken hawk. Of the considerable number of species in this general area, seven are distinguished by individual native terms. The goshawk and duck hawk, as represented by prepared skins, are unfamiliar to most informants. However, these are included with the prairie falcon, sharp-shinned hawk, and Cooper's hawk in the category of *omaχsistsípanikim*, "large barred feathers." Through an oversight the prepared skin of the pigeon hawk was not shown to informants. Hence the designation of that species can not be given.

Pispsksí, "high," sparrow hawk (*Falco sparverius* subsp.). The term has some now unknown reference to the bird's flight.

Omaχsapíspsksi, "big *pispsksí*", sharp-shinned hawk (*Accipiter velox*).

Otaχkúksoats, "yellow tailfeathers"; *ksikάpitapanikim*, "real white feathers," redtail hawk (*Buteo borealis* subsp.). The tailfeathers of this species are said by the Blackfeet to change color seasonally. Hence the former term is applied to the bird in winter; the latter in summer. Hayden: *sikúpetapunikimi*, gray hawk [?].

Sikpuítapanikim, "dark greasy feathers"; *isikaúkaii*, "black breast," Swainson's hawk (*Buteo swainsoni*). Hayden's *siketapunikimi* ["dark real feathers"], brown fish hawk, is tentatively equated by informants with this species. The latter term is applied also to the chestnut-collared longspur.

Ikpαksoátsimiop, "resemble (eagle) tailfeathers," American rough-legged hawk (*Buteo regalis*). The tailfeather markings of this bird are said to be such as to permit substitution of the feathers for those of the eagle in men's headdresses.

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[7] Through a typographical error the English identification of this term in Henry's list has been transposed to the line below.

[8] Blackfeet traditions remark the former abundance of the vulture and its feeding upon the carcasses of bison. Today it is rarely, if ever, seen about the Reservation. A similar decrease in the vulture population seems to have taken place throughout the state. Cameron (p. 259) quotes an early resident of eastern Montana, who attested to the abundance of the species in 1883, attracted by the prodigious slaughter of the bison. Thereafter, a rapid decline took place until by 1905 they had become accidental wanderers.

Apipisíoxsi, "white belt," marsh hawk (*Circus hudsonius*).

Paχtsíksistsikum, "false thunder," osprey (*Pandion haliaetus carolinensis*). The term is echoic of the sound made by the bird's wings during its flight dive. Informants are not familiar with Hayden's term *apetapúnikimi* ["light-colored feathers"], fish hawk.

Kitssítsum, "looks like smoke," Franklin grouse (*Canachites franklini*); ruffed grouse (*Bonasa umbellus* subsp.). These two birds are differentiated by the descriptive adjectives *matsápsi*, "crazy," applied to *Canachites*, and *ắpαskau*, "dancer," to *Bonasa*. Hayden: *kítsiitsim*, pheasant.

Omaχtsikítssitsum, "big *kitssítsum*," Richardson's grouse (*Dendragapus obscurus* subsp.).

Kétoki, "tough skin," sharp-tailed grouse (*Pedioecetes phasianellus* subsp.). The significance of the name has been lost, but it may be mimetic in origin. Hayden: *kítoki*, common prairie hen.

Apikétoki, "white *kétoki*," white-tailed ptarmigan (*Lagopus leucurus* subsp.).

Omaχsakétoki, "big *kétoki*," sage hen (*Centrocircus urophasianus*). Hayden: *omuksikítoki*, large prairie hen, sage cock.

Sékαm, an archaic term now believed to refer to "long legs," crane (Gruidae); *apssékαm*, "white *sékαm*," probably the whooping crane (*Grus americana*). Henry's term, *oopa*, is not recognized by my informants.

Otoxtoí, "carrying food," sora (*Porzana carolina*), possibly Virginia rail (*Rallus limicola limicola*). The name has some reference to the sora's packing food on its migration ride atop the back of larger waterfowl.

Aksíksksissi, "white beak," coot (*Fulica americana*).

Considerable confusion exists in the minds of the Blackfeet regarding the names and identities of the shorebirds. The same incertitude is evident in McClintock's data and may well go back to aboriginal times. Consequently, I have not been able to resolve present-day inconsistencies or equate modern terms with those of earlier observers. McClintock, possibly, and Hayden, probably, collected their terminologies on the basis of actual field identification. Hence the lack of correspondence between their lists and those of today is, most likely, to be charged against native inconsistency.

Soiatάkska, "shadow in the water"; *apitsótoii*, "removes something from the water," killdeer (*Oxyechus vociferus vociferus*) and semipalmated plover (*Charadrius semipalmatus*). Informants state that either name is applied indiscriminately to the two species. The latter term is said to be mimetic, but both are now interpreted in connection with an alleged bestowal of a medicine bundle by the Underwater Spirits. McClintock (1910, p. 483), states that *soyatakskan* refers to the snipe; in 1923 (p. 227), however, he related it to an odd combination of "a bird with long legs and black breast (spotted sandpiper)." Hayden does not give the name at all. The latter, however, identifies *apitsótoyi* merely as "a small prairie plover"; while McClintock, in his earlier work (p. 483), states that *ma-pit-so-to-e* is "a little smaller than a killdeer, but of nearly the same color." Hayden's related term, *amúkopitsótoyi*, a large prairie plover, is not recognized by my informants.

Kítsipitsikuyi, kítsipitsikoan, "hard to see young ones," upland plover (*Bartramia longicauda*). These terms presumably refer to the protective coloration of the plover fledglings. Hayden cites the term without identification; McClintock (1910, p. 483) refers it to the killdeer.

Sotαmstá, "rain maker," Wilson's snipe (*Capella gallinago delicata*). Origin of the name is assigned to the snipe's peculiar, circling, mating flight, which the Blackfeet say takes place during or after a rain. One source (UG, p. 29) refers the term to "a species the size of a blackbird with white stripes on tail."

Makénimau, "burial lodge," curlew (Scolopacidae). The origin of the name today is assigned either to (1) the curlew's habit of seeking insects formerly within abandoned burial lodges (RS), or (2) an alleged incident in which a medicine bundle containing the beak of a curlew was recovered from a burial tipi (NG).[9]

Otaχkuíka, "yellow legs," yellowlegs (*Totanus* sp.). The species is known to most informants, but only Under Mouse is familiar with its native name.

Aχkyókenimau, "water *makénimau*," avocet (*Recurvirostra americana*). Although other informants had seen the species, White Calf alone is familiar with the native name.

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[9] The term *makénimau* is also applied to the Museum of the Plains Indian by contemporary Blackfeet, because it serves as a repository for material culture items belonging to individuals now deceased.

Apauxkomíi, "white throat," Wilson's phalarope (*Steganopus tricolor*). Another term known only to Under Mouse.

Kaíi, gull (Larinae), probably the ring-billed species. A term now translated as "(porcupine) quill" but possibly onomatopoeic in origin. Hayden gives *kaíyi*, a kind of gull, and *omuksákaiyi*, a large gull. The latter term may refer to the herring gull.

Omaχsíksakαpansi, "big *siksakαpánsi*"; *axkyómaχsiksakαpansi*, "big water *siksakαpánsi*," tern (Sterninae), probably the black tern. The swallowlike characteristics of this bird appeal as much to the Blackfeet, terminologically, as to a modern ornithologist (H. K. Job, in Pearson, sect. 1, p. 67).

Káko, *saukyékako*, "prairie *káko*," mourning dove (*Zenaidura macroura marginella*) and domestic pigeon (*Columba livia*). The former term is mimetic.[10]

Sépisto, "night announcer"; *kαkαnotstóki*, "hollow ear," horned owl (*Bubo virginianus* subsp.). The former, which is also the generic term for the owls, has been characterized as a haplological dissimulation for **sepipistó*, "night nighthawk" (UG, pp. 153–54). The latter name is onomatopoeic. McClintock (1923, p. 114) erroneously translates it as "ears far apart." A variant for the same species is *mispiksíkαkαnotstoki*, "thick hollow ear," also echoic in origin.

Apsépisto, "white *sépisto*, snowy owl (*Nyctea nyctea*).

Spópiu, "alights on high," hawk owl (*Surnia ulula caparoch*). Named from its habit of flying low over the ground and swooping up sharply to alight in a tree top. One informant (RS) equates this species, terminologically, with the sharp-shinned hawk.

Atsítsi, "mitten," pygmy owl (*Glaucidium gnoma* subsp.). The name is likely derived from the final "two or three slow deliberate notes" (Peterson) of the bird's call. The Blackfeet, however, interpret it from the notion that a person can seize the owl, which is either so unwary or so blind in daylight, by approaching slowly with outstretched hand or "mitten," and calling softly, *atsítsi! atsítsi!*

Matási, "hollowed-out rectum," burrowing owl (*Speotyto cunicularia hypugaea*). Like the previous species, the name of this owl may have had its origin in onomatopoeia.

Paχtsisépisto, "imitation" or "false *sépisto*," long-eared owl (*Asio wilsonianus*). The size of this species led the Blackfeet to consider it a small replica of the horned owl.

Saukyesépisto, "prairie *sépisto*," short-eared owl (*Asio flammeus flammeus*).

Pistó, nighthawk (*Chordeiles minor* subsp.). Informants attempt to relate this term to the sound of the bird's flight dive. Its resemblance to the common Northeastern-Central Algonkian echoic designation (Speck, p. 256), however, suggests a similar origin in this case. The nighthawk is considered lazy because it does not build a nest like other birds but lays its eggs on the ground.[11]

Namoísistsi, "wasp bird," hummingbird (Trochilidae). The term is said to be derived from the hummingbird's resemblance to the wasp or bee.

Auαksauáni, "(pine) gum eater"; *kitsipaúkaii*, "striped breast"; *mamieínima*, "fish catcher"; *apkoχkíniyi*, "white neck," kingfisher (*Megaceryle alcyon* subsp.). These names are all except the first descriptive of the appearance or activity of the kingfisher. It is usually explained by reference to an incident in which pine gum was found within the bird's stomach. My interpreter, however, thinks the term might refer to the wingbeat tempo of the kingfisher. The first name, which is also a variant for Clark's nutcracker, is most commonly used today.

Mέkanikesuyi, "flashes red feathers," red-shafted flicker (*Colaptes cafer* subsp.). One source (UG, p. 174) gives "red woodpecker." The generic term for the woodpeckers is *páχpαksksissi*, "pounding nose."

Míkimata, "fire-reddened breast," red-headed woodpecker (*Melanerpes erythrocephalus*) and red-naped sapsucker (*Sphyrapicus varius nuchalis*). Hayden gives for the same term "a kind of small, speckled woodpecker." A variant for the former species is *ekotsótokan*, "red head."

Omaχsíkimata, "big *míkimata*," Lewis's woodpecker (*Asyndesmus lewis*). For this term Hayden gives "red-headed woodpecker."

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[10] Possibly this same term may have been extended to the passenger pigeon, although I came across no native traditions relating to it. Saunders (p. 171) notes that this species was "formerly an abundant migrant, evidently throughout the state, and probably breeding in the northern mountains." In this connection, the above-noted variant, "prairie dove," may have served to differentiate in some way the dove and the pigeon.

[11] The similarity of *pistó* to another Blackfeet word, *pístsit*, "to break wind," provides material for native punsters in folklore and conversation.

Siksíkanikesuyi, "flashes black feathers"; *okssíxkini*, "raw head," pileolated woodpecker (*Dryocopus pileatus picinus*). Hayden merely refers the name to "a black woodpecker."

Otaχkúnski, "yellow forehead," Arctic three-toed woodpecker (*Picoides arcticus*).

Sikiminíwani, "stingy with his berries," kingbird (Tyrannidae). The term, which reflects the aggressive qualities of the kingbird, is said to have its origin in a tale in which this bird frightened a bear from its berry patch.

Miátsi, horned lark (Alaudidae). The term is archaic and may originally have been imitative of the bird's call note. Hayden: *niátsi*, killdeer plover [?]. See chestnut-collared longspur.

Siksakαpánsi, swallow (Hirundinidae). A difficult term to translate. My interpreter suggests the lexical elements *siksiksi*, "willow tanned hide," and *αpansi*, "shows something on self." An earlier translation, "mud shows in beak," was rejected as incorrect.

Apiakúnski, "white forehead," Rocky Mountain jay (*Perisoreus canadensis capitalis*). The Blackfeet consider the male jay and the male nutcracker as male and female, respectively, of one species.

Makokím, "old lodge-cover (color)"; *auaksauáni*," (pine) gum eater," Clark's nutcracker (*Nucifraga columbiana*). The second term is based on the bird's alleged habit of feeding upon pine gum.

Omaχkútskuisistsi, "large *ótskuisistsi*"; *ótskuipiksi*, *ótskuisistsi*, "blue bird," Steller's jay (*Cyanocitta stelleri* subsp.). The last term is also applied to the bluebird (*Sialia*), the lazuli bunting (*Passerina amoena*), and other small birds of blue plumage.

Mamiátsikimi, "body like a fish," magpie (*Pica pica hudsonia*). Hayden: *mámaacíkim*. Henry's *wastoonah*, which my informants heard as *maistoína*, "Crow chief," is interesting as an earlier designation for the magpie.

Maistó, meaning unexplainable, crow (*Corvus brachyrhynchos* subsp.). Henry: *wasto*; Hayden: *másto*, beaver [sic].

Ṓmaχkaisto, "big *maistó*, raven (*Corvus corax* subsp.).

Népumaki, chickadee (*Penthestes* sp.). The name is onomatopoeic but reinterpreted today as "summer woman." Hayden assigns it to the tomtit. Another source (UG, p. 208) defines the word as "spring bird." The designation *nepe-e*, which my informants claim is an abbreviated form of the above, is referred to the white-throated sparrow by McClintock (1910, p. 482).

Ī́ksisakum, "meat," water ouzel (*Cinclus mexicanus unicolor*). The term may be mimetic in origin. Upon sighting this bird the Blackfeet, however, call *íksisakum! íksisakum!*, and it is said to dip in response. McClintock (1910, p. 483) refers the name to the ouzel but subsequently (1923, p. 185) transfers it to the sandpiper.

Matαksissáxkima, "uses nose to push out (nest)"; *istsikinipítsi*, "sings continuously," wren (Troglodytidae). The former term refers to the nest-building activities of the wren.

Pokaú, "child," catbird (*Dumetella carolinensis*). The term reflects the Blackfeet interpretation of the bird's cry as *na'á*, "mother."

Otaχkaúkaii, "yellow breast"; *otsisaúye*, "colored feathers," robin (*Turdus migratorius* subsp.). The latter name, more commonly used in earlier days, has now been displaced by the former. The robin's presence and song in days of tribal warfare indicated to the Blackfeet that the camp was peaceful and secure. Hence, its departure in the fall was observed with a feeling of regret.

Naistuiksíksoatsis, "white outside tail feathers," Townsend's solitaire (*Myadestes townsendi*).

Simítsima, "lodge-cover pole," waxwing (*Bombycilla* sp.). The Blackfeet lodge consists of a conical structure of poles enclosed by a hide cover secured to the tallest pole. The waxwing's name derives from the fancied appearance of its crest to this pole with its suspended lodge cover. In earlier times waxwings are said to have perched atop the lodge poles of winter camps.

Soχksísmistau, "makes (nest) like a big anus"; *matsaiíki*, "beautiful whistler," western meadowlark (*Sturnella neglecta*). The former is said to refer to the peculiar arched entrance of grass leading to the bird's nest; a somewhat different translation of the term is given by McClintock (1910, p. 482). The latter name is mimetic. McClintock (1910, p. 482) also gives o-toch-koki [*otaχkaúkaii*], "yellow breast," as a variant. The Blackfeet claim to understand the calls of the meadowlark. Among the native interpretations are *kinakíni otsitotsínnaiyixpi*, "where there's fat on the liver"; *kitákema* (*nitákema*) *siksistókiwa*, "your (my) sister's black skin"; *ekyotsístsini*, "roof of mouth is red"; *matsiíkiwa sikimákewa*, "good whistler (is a) stingy woman." All these expressions are mildly derisive in character.

Kseiní, cowbird (*Molothrus ater* subsp.) and

Brewer's blackbird (*Euphagus cyanocephalus* subsp.). Hayden: *kséni*, cow bunting; UG (p. 30): *kseni*, *kseiní*, blackbird. The bronze grackle, *omaχsákseini*, "big *kseiní*" (*Quiscalus quiscula aeneus*), is considered a closely related member of this group. Hayden: *omuksákseni*, crow blackbird. Some informants regard the grackle as male and the cowbird-blackbird as female; others the Brewer's as male and the cowbird female of a common species. The male cowbird is differentiated, terminologically, as *apiakssíkseini*, "lighter-colored *kseiní*." Hayden: *apiaksákseni*, brown blackbird. The term *kseiní* is echoic either of the harsh *chuck* or *check*, or the bubbly, squeeky song *kah-eee* or *klug-tseeee* (Peterson) of this group. Informants relate the term to *akseíni*, a word descriptive of the lowing of the bison. The element *-eini*, "bison," of *kseiní* represents an additional link, besides the symbiotic one,[12] between the cowbird and that animal.

Soyíkseini, "water *kseiní*," yellow-headed blackbird (*Xanthocephalus xanthocephalus* subsp.) and redwing (*Agelaius phoeniceus* subsp.). Hayden: *soyíksini*, water blackbird. Variants are *otaχkaúkaii*, "yellow breast" (UM), and *imaúkomini kseiní*, "red wing *kseiní*" (RS). The redwing is regarded as male and the yellow-headed blackbird as female of one species.

Inoxpínsoyi, "hanging nest," Bullock's oriole (*Icterus bullocki*). The species is known only to Sanderville and White Calf, and the former supplied the name.

Mikyótokan, "red head," western tanager (*Piranga ludoviciana*). Only Short Face and Green Grass Bull know the tanager, and the term is given by the former.

Pomisístsi, "grease bird," male goldfinch in summer plumage (*Spinus tristis*); *otaχkuitsístsi*, "yellow bird," the female goldfinch and other small birds of yellow plumage. The former term is derived, according to informants, from the bird's color resemblance to the back fat of the bison.

Isikótokani, "black head"; *motoísistsi*, "spring bird," junco (*Junco* sp.). The last term refers to the early return of the junco in spring.

There is less interest, terminologically speaking, on the part of the Blackfeet in the smaller song birds than most any other avian group. Besides those diminutive species already discussed, the Indians select but few other varieties for specific designation. Instead the generic terms *póksistsi* and *kopútsksissi*, and the color designations *otaχkuítsistsi* and *ótskuisistsi*, are applied to the vireos, warblers, song sparrows, etc.

Atsinesístsi, "Gros Ventre bird," bobolink (*Dolichonyx oryzivorus*). The Blackfeet understand the bird's call as *atsiné*, their name for the Gros Ventre Indians. The latter are said to understand the bobolink's song. The song interpretation, "Spread your robe and I will alight upon it" is credited by my informants to the bobolink (RS) and summer longspurs (NG), and by McClintock to the chestnut-collared longspur (1910, p. 482) and horned lark (1923, p. 227).

Kopútsksissi, *kópsksissi*, "small nose," nuthatch (Sittidae), creeper (Certhiidae), and kinglet (Sylviidae). Variant terms for the gold-crowned and yellow-crowned kinglets are *imáχkini*, "red head," and *otaχkuíkini*, "yellow head," respectively.

Otsikékinaχsoatsis, "shoulder-bone tailfeathers," McCown's longspur (*Rhynchophanes mccowni*). Informants say that the name reflects comparison of the white portions of the species" tailfeathers to a bleached bone. This species is differentiated from the chestnut-collared longspur by its parachuting flight descent while in song. Assignment of the same term to the "snow bird" by UG (p. 195) demonstrates the native misconception that the respective summer and winter migrant longspurs are a common species residing continuously in the area throughout the year.

Isikaúkaii, "black breast," chestnut-collared longspur (*Calcarius ornatus*). This term may also represent a variant for the horned lark. McClintock (1910, p. 482), although first referring the name to the longspur, later assigns it to the lark. Hayden also gives "lark." There is considerable confusion in the minds of modern Blackfeet over the identities and names of the small winter migrants and related summer species.

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[12] Taverner (pp. 376–377) notes that "in early times it [the cowbird] probably followed the buffalo, which suggested its old, nearly forgotten name of Buffalo-bird." In one of his popular novels, James W. Schultz (p. 129) has evoked memories of a faunal relationship, which must have been very familiar to the Blackfeet of an earlier period: "The fluttering and scolding of the buffalo-birds now warned us to be ready. These little creatures, a dusky variety of blackbird, lived constantly with the buffalo from early spring until winter drove them to a warmer clime. They were benefactors of the big, shaggy animals, perching upon their backs the greater part of the time and keeping them free from flies and other insect pests. They were angry now because the brush overhanging the trail kept sweeping them from their perches."

Istuísistsi, "cold [winter] bird"; *apinákuisistsi*, "morning bird," snow bunting (*Plectrophenax nivalis nivalis*) and Alaska longspur (*Calcarius lapponicus alascensis*). Unaware also that the snow bunting migrated northward in spring, the Blackfeet attempt to equate it, after a seasonal change of plumage, with the chestnut-collared longspur.

Nipuaúeks, "arises early," domestic rooster; *nitauáke*, "lone woman," domestic hen. Hayden: *ōhúmi*, "bird that screams." *Omaxsápiksi*, "big *piksí*," domestic turkey. The first two terms are mimetic in character.

The Blackfeet assign the bat (Chiroptera) to the avian world and like the Gros Ventre (Kroeber, p. 281) consider its bite poisonous. The following names for the bat are given: *áukspiaki*, "clings to anything"; *matsiipítau*, "fine eagle"; *motínstami*, "many lodge poles"; *motsinípita*, "pretty labia." The last two designations are descriptive of the bat's appearance, the former referring to the cartilaginous wing ribs.

Analysis of the foregoing data provides some insight into the problem of how a preliterate people classify one segment of the multivaried phenomena of their external world. The Blackfeet have selected for naming some 80 odd species (in some cases, families) of the avian world and have built a total, including synonyms, of more than 100 different terms. In the few studies of this kind thus far made, Speck (p. 251) has recovered 75 bird names from the Penobscot of Maine and 70 from the Canadian Delaware; Witthoft (p. 373) writes of one North Carolina Cherokee's knowledge of 100 terms; while Gunther (pp. 105–118) has salvaged 45 from a Makah informant of Washington Coast.

For the Canadian Delaware the ratio of descriptive to mimetic terms is 2 to 1. In Blackfeet nomenclature, 90-odd terms are based upon factors of appearance-behavior and only 15 upon utterance, a ratio of 6 to 1. The preponderance of descriptive over echoic names in Blackfeet terminology may reflect a relatively recent development, since many of the archaic terms for plains-dwelling birds are apparently onomatopoeic in origin. During the present study, the writer observed that modern Blackfeet tend to denominate unfamiliar species in terms of color idiosyncrasies. So much for the quantitative aspects of Blackfeet nomenclature.

Blackfeet taxonomy, as revealed in the list of native bird names, is based not upon "essential identities of structure and development," as in modern ornithology, but largely upon gross and superficial similarities due to function. The inability of the Blackfeet to distinguish fundamental relationships in the realm of feathered wildlife is manifested at numerous points in their name system. The flight pattern of the tern, the aquatic habits of the avocet, the color of the bluebird led the Indians to classify them, respectively, with quite unrelated species. Terminological utilization of attributes of *form*, *habit*, and *utterance* coincides with the selection patterns of other ornithologically known tribes, and perhaps exhausts the possibilities of choice.

Another principle of Blackfeet taxonomy revealed in their terminology is the use of *omaχ*, "large," a prefix modifier in a number of bird names. The employment of this adjectival element is based upon the native belief, still enunciated today, in the existence of both a large and small variety of the same bird. Hayden's list shows marked evidence of this notion, apparently an old one in Blackfeet concept. I was unable to secure a rationalization of the belief, if such ever existed.

Native observation of bird life and habits, as reflected terminologically, is in some particulars acute, in others obtuse. An example of the latter is the crossing of species' lines in sex identification of the cowbird-blackbird group. Another is the failure to recognize migration as a factor in differentiation of the summer and winter larkspurs. Finally, it should be noted that the ideological screen of traditional meanings through which the Blackfeet view the birds, has also served to obscure certain basic relationships in the avian realm.

The question arises as to the relationship of Blackfeet nomenclature to the terminological systems of adjacent tribes in the Northwestern Plains. Lack of data prevents comparison not only with the linguistically related Plains Cree, Gros Ventre, and Cheyenne but with other groups in this region. If we perforce turn to those more distant but ornithologically known Algonkians of the Eastern Woodlands, we find that correspondences are few and of a generalized nature. In Speck's Delaware-Penobscot material (p. 252), such apparent points of similarity occur as Wabanaki *si·ps*, *sisip*, etc., and Blackfeet *sistsí*, all generic terms for bird. Similarly, a comparison might be made of Blackfeet *pistó* and Canadian Delaware *pi·ck*^{w}, Oklahoma Delaware *pick* and Penobscot (-Ojibway) *pesk* (Speck, p. 256), all designation for the nighthawk. However, since both sets of terms are probably onomatapoeic and since other eastern Algonkians have quite diverse forms, the evidence for genetic connections is slight.

It appears, then, that native faunal terminologies are no more stable than other preliterate conceptual systems under influence of culture change. In fact Witthoft (p. 372), in connection with his Cherokee study, has called attention to the possibility that in an acculturation situation, traditional knowledge in the field of natural history may be one of the first constellations to be destroyed. More specifically, Speck (p. 252) has pointed out the linguistic divergence set in motion only since the American Revolution between the Oklahoma Delaware and the Delaware in Canada in respect to their generic term for bird. In view of these findings, it is not surprising to find so little correspondence between the bird nomenclatures of the Blackfeet and their linguistic congeners in the east.

In summary, if the terminological elaboration in Blackfeet ornithology may be considered a rough index of that group's interest in the world of bird life, it is evident that their avian horizon is as wide as that of most other Indian tribes investigated. Insofar as popular imagination has pictured the Blackfeet as narrowly oriented toward and predominantly preoccupied with but one faunal species, the plains bison, to the same degree are such traditional notions subject to revision.

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BOTANY.—*Five new Asteraceae from Mexico and South America.*[1] S. F. Blake, Bureau of Plant Industry, Soils, and Agricultural Engineering.

The new species here described have been found in various small collections sent for identification during the past few years.

Piqueria loxensis Blake & Steyermark, sp. nov.

Herbacea annua; caulibus erectis infra simplicibus 4.5–5 dm longis moderatim pubescentibus; internodiis plerumque 6–13 cm longis; foliis oppositis graciliter petiolatis, petiolis majusculis 14–18 mm longis, laminis ovato-triangularibus apice obtusis basi truncato-ampliatis integris ceterum margine grosse crenatis supra moderatim hirsutulis subtus praecipue in nervis hirsutulis et cum glandulis resinosis sessilibus ornatis, majoribus 3.5–4 cm longis 3.5–3.7 cm latis; capitulis 60–65-floris; phyllariis biseriatis 15 late spatulatis vel obovato-oblongis 2.2–3 mm longis 1.2–1.5 mm latis margine dense ciliatis; corollis 1.3–1.5 mm longis tubo dense pilosulo lobis ovatis papillatis; achaeniis 5-costatis glabris 1.1 mm longis.

Herbaceous annual; stems erect, simple below, loosely corymbosely branched above, subterete, 4.5–5 dm tall, moderately pubescent with mixed short and elongated (up to 1 mm) simple multicellular eglandular trichomes, lateral secondary branches 7–12 cm long; internodes 6–13 cm long; leaves opposite, petioles slender, 1.4–1.8 cm long on main cauline leaves, blade triangular-ovate, obtuse at apex, truncate-broadened at base subcuneately narrowed in the middle at junction with petiole, coarsely crenate above the base with 7–9 ovate-oblong obtuse to rounded teeth (the lower ones more prominent), membranaceous, triplinerved, moderately hirsutulous above, hirsutulous below especially on midrib and lateral nerves, with numerous sessile glands scattered over lower surface, largest leaves 3.5–4 cm. long, 3.5–3.7 cm wide in the lower half; inflorescence corymbosely cymose, of 5–9 heads in each cluster at the apex of the branches; heads 60–65-flowered; involucre broadly campanulate; phyllaries biseriate, subequal, 15, shorter than the florets, broadly spatulate to obovate-oblong, rounded at summit, narrowed below, somewhat 2-ribbed at base, 2.2–3 mm long, 1.2–1.5 mm wide, densely ciliate, especially in upper half, with 1–2-celled simple acuminate trichomes, faintly 3–5-nerved, the nerves not extending to and branching before reaching the margins; corollas 1.3–1.5 mm long, tube 0.3–0.5 mm long, densely pilosulous with subreflexed simple articulate trichomes, the throat and lobes together 1 mm long, lower part of throat sparsely beset with short glandular hairs, the broadly ovate lobes 0.3 mm long, subacute, sparsely papillose without; anthers delicately united by their margins, inappendiculate, 0.3–0.4 mm long; filaments slender, 0.5 mm long, glabrous; style branches exserted, subterete, 1.3 mm long, about the same width throughout, thickened at or near the tip; achenes 5-costate, 1.1 mm long, blackish; pappus a low crown; podium well-developed.

Ecuador: Prov. Loja, Cerro Pucará, alt. 2,300 meters, May 18, 1946, *Reinaldo Espinosa 405* (type, in Herb. Chicago Nat. Hist. Mus., isotypes in N. Y. Bot. Gard. Herb. and U. S. Nat. Arboretum).

This species differs from *P. sodiroi* Hieron., to which it is closely related, by having 15 instead of 10–12 phyllaries, which are somewhat broader in the upper half; the corolla throat sparsely covered with short minute gland-tipped hairs, whereas in *P. sodiroi* the glands are large and conspicuous, the hairs of the corolla lobes short, whereas in *P. sodiroi* they are much more numerous and more elongated; the heads somewhat larger, with more numerous florets; the leaves larger, with shorter trichomes on lower surface of blades and longer petioles; the stems erect and single instead of procumbent and several, with longer internodes and fewer and more remote leaves; and the phyllaries more uniformly ciliate and more conspicuously 2-ribbed at base.

Aplopappus pseudobaccharis Blake, sp. nov.

Frutex scoparius metralis glaberrimus modice resinosus, ramis et ramulis multis erectis pallide viridibus striato-angulatis; folia anguste linearia integerrima plana paullum incrassata omnino non vel solum supra obscurissime punctata usque ad 1.4 cm longa 1 mm lata; capitula parva radiata 12–15-flora aurea pseudoracemosa 5–15 per ramum, pedunculis 1-cephalis inferioribus bracteatis usque ad 3 cm longis superioribus 1–2 mm longis vel subnullis; involucri ca. 3.5 mm alti turbinati gradati 4–5-seriati phyllaria oblonga obtusa v. acutiuscula chartacea apice viridescen-

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[1] Received August 22, 1949.

tia margine scariosa; radii 4–6 parvi, lamina ca. 2 mm longa; achenia dense et appresse sericea.

Broomlike shrub, 1 m high; stem slender, in age whitish-barked; branches and branchlets about 5-angled, 1 mm thick or less; internodes mostly 5–10 mm long; leaves wanting except on branches of the year, without axillary fascicles, erectish, obtuse or sometimes subacutely callous-pointed, pale green, the midrib beneath marked by a glandular vitta, the branch leaves smaller, mostly 3–8 mm long; heads (moistened) 6 mm high (excluding styles), about 4.5 mm wide; phyllaries oblong or oblong-ovate, obtuse or the outer acutish, glabrous but often obscurely subglandular-denticulate at apex, scarious-margined except toward apex, the single glandular vitta slightly enlarged toward tip into an inconspicuous linear gland, the outermost phyllaries about 2 mm long, 0.9 mm wide, the middle and inner about 3 mm long, 1–1.3 mm wide; receptacle irregularly fimbrillate-setiferous, the fimbrillae or setae up to 0.5 mm long; rays 4–6, the lamina elliptic, spreading, 2–3-denticulate or 2-dentate, 3–4-nerved, 2–2.3 mm long, 1–1.3 mm wide, the tube 1–1.3 mm long, sparsely short-hairy above; disk flowers 8–9, their corollas rather slenderly obconic, sparsely puberulous on tube above, unequally 5-cleft, 4.3 mm long (tube 1 mm, throat 1 mm, one tooth 2.3 mm, the others 1.3 mm long); achenes oblong, 6–7-ribbed, 1.3 mm long, densely short-silky, the prolongation of the upper hairs beyond the achene simulating an outer pappus; pappus 3.5 mm long, of 24–28 subequal minutely hispidulous stramineous bristles; style appendages (disk flowers) lanceolate, obtuse, 1 mm long, equaling the stigmatiferous lines.

Mexico: Large colony on arid limestone hillside, Valle Seco, Sierra Paila, General Cepeda, Coahuila, 1,700 m, July 4, 1944, *James C. Hinton* (G. B. Hinton et al. 16546) (type, no. 1890353, U. S. Nat. Herb.).

The essentially complete absence of impressed glands in the leaves of this plant places it technically in Hall's section *Asiris*, which contains no closely similar species. Its closest natural relationship is clearly with *A. palmeri* Gray of the sect. *Ericameria*, but in that species of southern California and Baja California the branches are terete or subterete and very leafy, the leaves are longer, always densely punctate, and normally provided with axillary fascicles, and the involucre is longer.

Diplostephium abietinum Blake, **sp. nov.**

Frutex humilis; rami compacte ochraceo-tomentosi dense foliosi demum defoliati cicatricosi; folia linearia patentia crassiuscula ca. 8 mm longa 1 mm lata apice obtuse callosa sessilia margine revoluta supra valde resinosa juventate paullum pilosula subtus ochraceo-cinereo-tomentosa; capitula solitaria majuscula subsessilia radiata; involucri 10–11 mm alti ca. 6-seriati valde gradati phyllaria lanceolata acuminata piloso-cilata et praecipue exteriora dorso laxe cinereo-pilosa; achenia dense hirsutula.

"Low growing shrub"; upper part of stem (terete, 2.5 mm thick) and branches closely and not very thickly ochraceous- or in age cinereous-tomentose, densely covered with the imbricated bases of fallen leaves, these deltoid, obtuse, about 1.5 mm high and wide, decidedly wider than the leaf blades; branches subverticillate, 3–4 cm long, erectish; leaves above grayish green, resin-coated but dull, when young thinly cinereous-pilosulous but soon glabrate, not spinulose or glandular, beneath densely ochraceous- or in age cinereous-tomentose, 1-nerved, the margins revolute to the edge of the midrib beneath, the midrib strong, rounded and somewhat elevated above (the leaf thus sulcate on each side of midrib), concealed by the tomentum beneath, the apex of leaf brownish, denudate, obtusely callous-tipped; heads solitary at tips of branches, 1.6–2 cm wide (as pressed), sessile or on a peduncle 2 mm long; phyllaries chartaceous, whitish, rather strongly 1-nerved, about 1.5 mm wide; rays about 21, of unknown color, the tube 1.5 mm long, sparsely puberulous toward apex, the lamina linear-elliptic, 3-denticulate, 4-nerved, 8.5 mm long, 1.7 mm wide; disk flowers numerous, their corollas sparsely pilosulous toward base of throat, 5.3 mm long (tube 1.8 mm, throat slenderly funnelform, 2.8 mm, teeth spreading, 0.7 mm long); achenes of ray obovoid, somewhat compressed, 5-nerved, about 2 mm long, rather densely erect-hirsutulous, not glandular, their pappus of about 20 hispidulous bristles 5.5–6.5 mm long and an outer series of setiform squamellae 0.7–1 mm long; achenes of disk similar, 2.5 mm long, the bristles about 25, 5 mm long, the outer pappus of setiform squamellae 1–1.2 mm long; pappus purplish; style branches of disk flowers linear, acuminate, dorsally hispidulous, 1.6 mm long.

Peru: In full exposure, Piscohuañuno Pass, near Rioja, Dept. Amazonas (?), 3,050 m, August

1938, *Christopher Sandeman* 13 (TYPE, Herb. Kew; photograph and fragment, U. S. Nat. Herb.).

This plant is a member of the group in the series Lavandulifolia having leaves not impressed-glandular above and a large involucre. It is distinguished from others of this group by having short, linear leaves, resinous-coated but scarcely if at all tomentose on the upper surface, and not spinulose. The species is described from a single stem-apex 15 cm long.

It is uncertain whether the type locality is in the Department of San Martín or Amazonas. Rioja is shown on the American Geographical Society's 1938 map (Loreto sheet) as in San Martín, about 20 km west of Moyobamba; the Cerros de Piscohuañuno as nearly 40 km farther west, in the Department of Amazonas. On the basis of the altitude given, the Pass is presumably in Amazonas, in the Province of Chachapoyas.

Montanoa gentryi Blake, sp. nov.

Arbor gracilis; rami subteretes glabri; folia superiora ovata acuminata basi cuneata crenato-serrata non lobata 3-plinervia supra lepidoto-hispidula scabra aetate laevia et lucida subtus subdense griseo-pilosula pilis incurvatis et glanduloso-adspersa, lamina ca. 6 cm longa 2.5 cm lata, petiolo ca. 8 mm longo; capitula parva 4–5-flora discoidea vel saepius radio unico praedita breviter pedicellata dense cymoso-paniculata; paleae dense pilosae, apice patente pungente.

"Slender tree with fissured trunk and dark heart wood"; branches of the year brownish white, slender, 1.5–2 mm thick, the internodes 5–25 mm long, the older branches grayish; leaves opposite; petioles densely pilosulous with ascending hairs, glabrescent, 5–10 mm long; blades gray-green, firm-papery, triplinerved about 8 mm above the cuneate unappendaged base and with 2 pairs of weaker nerves below the main nerves, somewhat bullate above in age, 5.5–6.5 cm long, 1.5–3 cm wide; panicles terminal, flattish or somewhat rounded, 8–10 cm wide, very many-headed, densely pilosulous with ascending to spreading hairs, the lower bracts leaflike, small, lanceolate, 1.8–4 cm long including petiole, the upper minute and squamiform, the pedicels mostly 2–4 mm long, densely spreading-pilose; disk (moistened) 7–8 mm high (including corollas), about 3–4.5 mm thick; involucre 1–2-seriate, the phyllaries 5–9, ovate, acute to acuminate, apiculate or cuspidate, densely pilose, 3–5-nerved, 1.3–2.8 mm long, 0.7–1.5 mm wide; ray when present neutral, white, stipitate-glandular on tube and back, the tube 1–1.3 mm long, the lamina oval or oblong-oval, 5–6-nerved, 3-dentate, 2.7–4.5 mm long, 1.5–2 mm wide; disk corollas 3–5, white, hirsutulous on tube, upper part of throat, and teeth, 3.5–4.2 mm long (tube 1.3 mm, throat 1.6–2 mm, teeth 0.7–1 mm long); fruiting pales firm, 5 mm long, densely long-pilose, the straight triangular-subulate stiff tip about 1.5 mm long, spreading at an angle of about 45°; achene obovoid, plump, blackish, 2.5 mm long, epappose.

MEXICO: Rocky canyon rim, short-tree forest, Capadero, Sierra Tacuichamona, Sinaloa, alt. 1,065 m (3,500 feet), February 13, 1940, *H. S. Gentry* 5614 (TYPE, no. 161373, herb. U. S. Nat. Arboretum).

The heads of this species have usually 1 ray and 3 disk flowers, but sometimes 4 or 5 disk flowers and no rays. It is a member of the section *Eriocarpha*, probably nearest *M. seleri* Robins. & Greenm. of Chiapas. In that species the heads have more flowers and the phyllaries are much less pubescent, in fact definitely green in anthesis. It is also related to *M. microcephala* Sch. Bip., which is still known only from the type collection made by Liebmann (no. 483) at Ejutla, Oaxaca. In this the petioles are narrowly margined to base, the ray flowers are 3, and the disk flowers 12 (fragments of type examined in U. S. National Herbarium).

In its about 4-flowered, sometimes discoid heads *M. gentryi* suggests *M. anomala* Robins. & Greenm. (*M. hemsleyana* (Kuntze) Blake, based on a hyponym) and *M. rekoi* Blake. In the former the leaf blades are as broad as long and densely rusty-pubescent beneath; in the latter, a stout tree of Oaxaca with a trunk up to 0.5 m thick, the leaves are similar in shape to those of *M. gentryi* but are soon glabrate beneath. *M. rosei* Robins. & Greenm., which is similar in foliage to *M. gentryi*, has much larger phyllaries (5–6 mm long in anthesis) and more numerously flowered heads.

Flourensia solitaria Blake, sp. nov.

Frutex parvus ramosus paullum glutinosus, ramis erectis monocephalis, caule dense hirtello; folia parva oblanceolata v. majora obovata subsessilia integerrima acuminata disperse hispidula penninervia v. obscure triplinervia; capitula discoidea mediocria solitaria ca. 30-flora longiuscule pedunculata erecta; involucri ca. 5-seriati gradati 10 mm alti phyllaria extima lanceolata acuminata interiora oblongo-obovata acuta v. acuminata, omnia basi indurata apice herbacea appressa v. extima parum laxa; achenia valde costata subglabra, pappo nullo.

Bush 0.3–0.6 m high, with numerous erectish branches, resinous-scented; stem with grayish-brown fissured bark, densely hirtellous with very short thick white hairs, more or less glabrate; branches normally simple, very slender, brown, striate-angulate, pubescent like the stem but only sparsely and irregularly so, often nearly glabrous above; internodes mostly 6–10 mm long on lower part of branches, 1.8–3.5 cm long above; leaves oblanceolate or the larger obovate, often with fascicles or short branchlets in their axils, 1.8–3.3 cm long, 3–10 mm wide, coriaceous, slightly resinous, plane, light green both sides, inconspicuously pubescent like the stem, narrowed into a petioliform margined base, loosely somewhat impressed-reticulate, subulately callous-tipped; peduncles slender, 3–5 cm long, naked or 1-bracteate, not thickened below the head; disk campanulate or campanulate-hemispheric, 12–13 mm high, 8–13 mm thick (as pressed); outermost phyllaries lanceolate, 4.5–6 mm long, about 1.5 mm wide, acuminate, sparsely and obscurely hirtellous, with short pale indurated base and much longer appressed or loosely erectish herbaceous tip, the middle ones oblong or lance-oblong, about 2.5 mm wide, ciliolate, many-vittate, the inmost obovate-oblong, acute, with short herbaceous tip; pales rather narrowly cuneate-spatulate when flattened out, acute or obtuse, apiculate, 10–11.5 mm long, slightly hirsutulous on back and obscurely ciliolate at tip, about 5-vittate, subscarious with greenish tip; disk corollas golden-yellow, resinous-granular on the teeth, 7.5–8.3 mm long (tube 1.5–1.8 mm, throat subcylindric, 5–5.5 mm, teeth ovate, obtusish, 1 mm long); achenes obovoid, plump, strongly 5–6-ribbed and with 1 or 2 usually weaker ribs between each pair of strong ribs, resinous, obscurely puberulous between the ribs above, not ciliate, epappose, 4.8–5.5 mm long, 2–2.5 mm wide.

Mexico: Rocky flats and slopes, top of grade at Cuesta de Zozaya (along road from Ocampo west over the mountains to Puertecito via Cuesta de Zozaya), Coahuila, September 20, 1941, *I. M. Johnston* 9289 (type, Gray Herb.; photograph and fragment, herb. U. S. Nat. Arboretum).

Nearest *Flourensia cernua* DC. but very distinct in its narrower, mostly oblanceolate leaves, its larger erect heads solitary at the tips of the branches, and its obovoid, strongly ribbed, subglabrous, epappose achenes.

MYCOLOGY.—*Some Cuban Phycomycetes.*[1] F. K. Sparrow,[2] University of Michigan.

When we consider the luxuriance and diversity of the phanerogamic flora of the Tropics, it is not surprising to find as our knowledge of the soil microflora of this region is increased that here, too, is a rich area awaiting intensive study. The fungi herein described were obtained from the provinces of Las Villas (Santa Clara) and Matanzas in central Cuba. With one exception they were all collected by the author from extremely dry soil during a prolonged period of drought. In addition to these fungi a number of other already described species were found. These will be discussed in another, more extensive paper. The methods of isolation employed are similar to those used by other workers in this field (Couch, 1939, et al.) and need not be repeated here.

Phlyctorhiza peltata, sp. nov.

Thallus unicentricus, raro multicentricus, superficialis in exuviis anguis, et ceteris; rhizoideis varie ex thallo orientibus, diametro 3μ (vel minus) ad originem, sursum angustatis et modice ramo-

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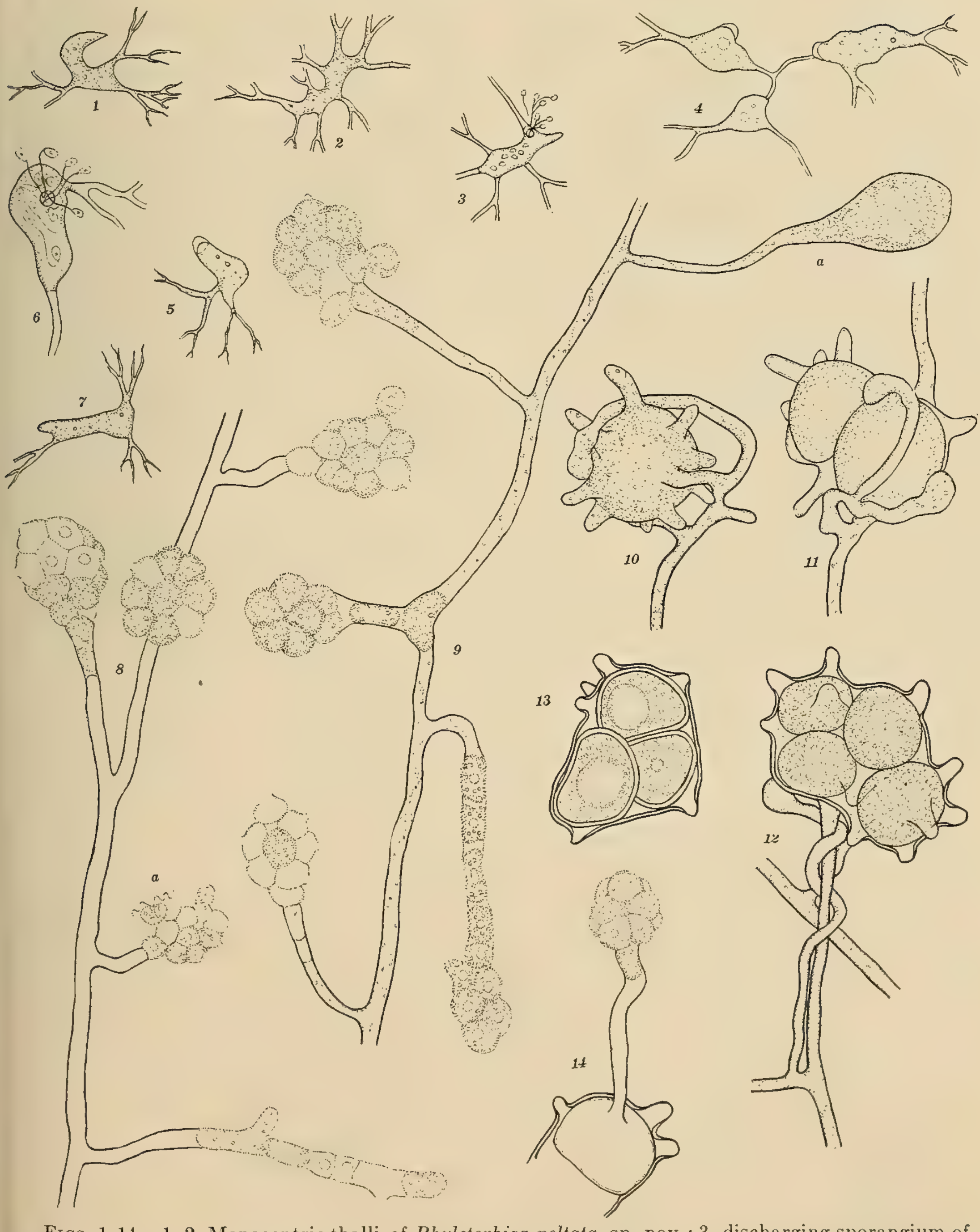
[1] Publication no. 5, Journal Series from the Atkins Garden and Research Laboratory of Harvard University, Soledad, Cienfuegos, Cuba, and Contribution no. 899 from the Botany Department, University of Michigan. Acknowledgment is made to the executive board of the Horace H. Rackham School of Graduate Studies for a grant from the Faculty Research Fund, which made these studies possible. Received August 22, 1949.

Slides of the new forms are in the writer's collections.

[2] It is a pleasure to acknowledge with thanks the many courtesies extended to the writer by the Atkins family, especially Mrs. E. F. Atkins, and by Dr. A. G. Kevorkian, lately director of the Atkins Gardens and Research Laboratory.



Figs. 1–14.—1, 2, Monocentric thalli of *Phylctorhiza peltata*, sp. nov.; 3, discharging sporangium of same; 4, polycentric thallus of *P. peltata*; 5, nearly mature sporangium showing discharge papilla; 6, discharging sporangium at higher magnification (× 650); 7, thallus of *P. peltata*. 8–14, *Aphanodictyon papillatum* Huneycutt: 8, portion of thallus bearing zoosporangia (a, zoospores in process of leaving cysts); 9, portion of thallus bearing sporangia of different shapes (*a*, one in process of formation); 10, young oogonium with encircling androgynous antheridial branches; 11, more mature sexual apparatus, the oogonium bearing two eggs; 12, oogonium with one androgynous and one diclinous antheridium; 13, old oogonium bearing mature oospores; 14, germinated oospore with germ tube bearing a single sporangium. (Figs. 1–3, 5, 7, × 330; Figs. 4, 6, 8–14, × 650.)

sis. Zoosporangia irregularia, longe peltata, 15–28μ longitudinaliter et 5–8μ transverse metientia, maturitate papillam singulam formantia demum a deliquescentia in porum sessile diametro 5μ transformantem. Zoosporae ovoideae 4μ longae, 2μ crassae, globulo refractivo et flagello postico ad apicem corporis angustiorem affixo praeditae. Sporae durantes non observatae.

Saprophytum in anguis exuviis ex rivulo prope Sanctam Claram in provincia "Las Villas," Cuba, 24 Mar., 1949.

Thallus monocentric, rarely polycentric, resting on the surface of the substratum; rhizoids arising from several places on the thallus, 3μ or less in diameter at point of origin, tapering and moderately branched distally. Zoosporangia irregularly and elongately peltate, 15–28μ along the long axis, 5–12μ along the shortest; at maturity forming a single papilla, which at maturity deliquesces to form a sessile exit pore 5μ in diameter. Zoospores ovoid, 4 by 2μ, with a minute refractive droplet and a long posterior flagellum attached to the narrower end of the body. Resting spores not observed.

Saprophytic on snakeskin in stream 5 miles west of Santa Clara, Las Villas Province, Cuba; March 24, 1949.

The species differs strikingly from *Phlyctorhiza endogena* Hanson and *P. variabilis* Karling in the peltate, irregular (never spherical) shape of the sporangium and sessile exit pore (Figs. 1–7). Other, less conspicuous features also separate it from the aforementioned forms.

Nowakowskiella atkinsii, sp. nov.

Thallus patens, multiramosus paucas tumiditates irregulares ferens etiamque raro partes (functionis ignotae) magnas setigeras 1- vel 2-cellulares turbinatas. Sporangia terminalia in apicibus ramis plus minusve elongatis vel raro intercalaria, saepissime sphaerica, raro subpyriformia, diametro 13–20μ, saepe apophysata; membrana paucas setas flexuosas 9–16μ longas ferente. Zoosporae subovoideae 5μ longae, 3μ crassae, globulo singulo et flagello postico praeditae, per porum lateralem vel subbasalem dehiscentia operculi 8μ diametientis emergentes, primum ante motilitatem exhibentes campacte aggregatae. Sporae durantes ignotae.

Saprophytum in substantis artificiali cellophanum dicta ex solo saxigeno in planitiebus sterilibus serpentinis prope Sanctam Claram, in provincia "Las Villas," Cuba, 24 Mar., 1949.

Thallus extensive, much branched, bearing occasional irregular swellings and rarely very large (35–40μ × 18–25μ) setigerous 1- or 2-celled turbinate organs. Sporangia at the tips of more or less elongated branches, rarely intercalary, predominantly spherical and 13–20μ in diameter or somewhat pyriform, often apophysate; the wall bearing a variable number of somewhat thickened flexuous setae, 9–16μ long. Zoospores slightly ovoid, 5 by 3μ with a single hyaline globule and posterior flagellum; emerging through a lateral or subbasal slightly elevated pore upon the dehiscence of an operculum 8μ in diameter and remaining in a compact quiescent group before assuming motility. Resting spore not observed.

Saprophytic on cellophane, in soil from serpentine savanna country 2 miles west of Santa Clara, Las Villas Province, Cuba, March 24, 1949.

This species is distinct from all others of the genus in having setae on the sporangia and turbinate cells (Figs. 25, 26).

Blastocladiopsis, gen. nov.

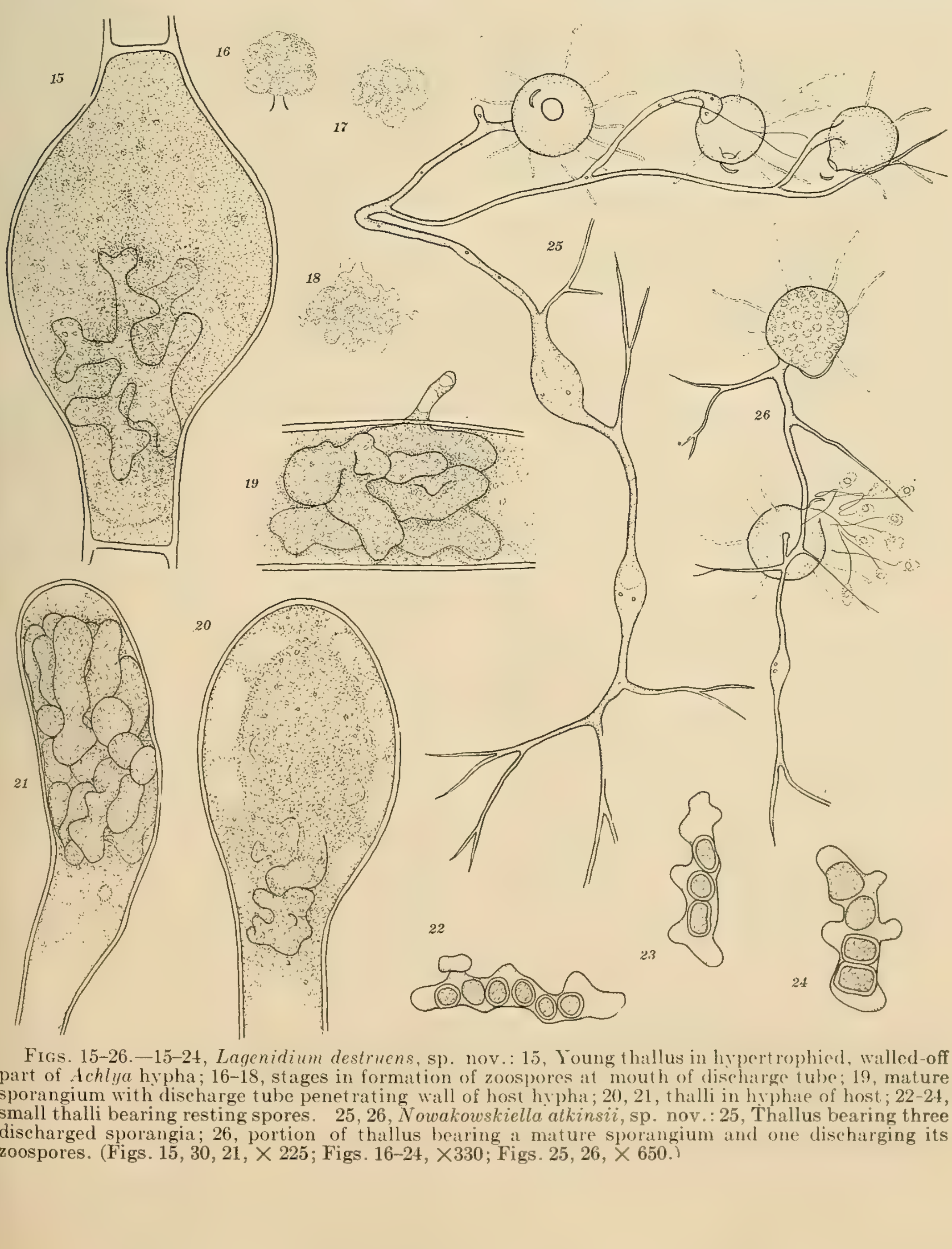
Thallus filamentosus absque cellula basali definita, usque ad originem partium sexualium non septatus, ad substrato adfixus a rhizoideis crassis. Zoosporangia irregularia vel subcylindrica; papillis emittientibus 1–6. Zoosporae postice uniflagellatae, globulis oleiferis pluribus et nucleo galericulato praeditae. Sporae durantes plerumque globulares vel interdum subellipsoidales, singulatim et mobiliter contentae, membrana aurea, laevi, non punctata circumdatae, demum germinatione fractae et zoosporas per poros paucos postice flagellatas emittientes. Gametophyton ignotum.

Thallus filamentous, without a well-defined basal cell; nonseptate except where reproductive organs are delimited; dichotomously or subdichotomously branched; anchored to the substratum by a system of coarse-branched rhizoids. Zoosporangia irregular or somewhat cylindrical, with 1–6 discharge papillae. Zoospores posteriorly uniflagellate, with several oil globules and a conspicuous nuclear cap. Resting spores usually spherical or somewhat ellipsoidal, with a thin, golden to amber-colored smooth, nonpunctate wall; borne singly and loosely within their container; upon germination cracking open and discharging posteriorly uniflagellate zoospores through one or more pores. Gametophyte unknown.

Blastocladiopsis parva (Whiffen), comb. nov.

Blastocladia parva Whiffen, Journ. Elisha Mitchell Sci. Soc. **59:** 40. 1943.

Thallus 300μ or more in length, unbranched or more commonly dichotomously or subdichomously branched; hyphae 12–50μ in diameter, somewhat irregular. Zoosporangia rare, terminal on the hyphae, irregular or somewhat cylindrical, 40 by 65.6 to 41.3 by 90.2μ, with 1–6 discharge papillae. Resting spores lying loosely in a smooth-walled or occasionally apically papillate container, spherical, ellipsoidal or ovoid, 36.8 by 41μ to 35.2 by 77.1μ, with a pale amber colored smooth, non-punctate wall; upon germination the wall cracking open and posteriorly uniflagel-



FIGS. 15–26.—15–24, *Lagenidium destruens*, sp. nov.: 15, Young thallus in hypertrophied, walled-off part of *Achlya* hypha; 16–18, stages in formation of zoospores at mouth of discharge tube; 19, mature sporangium with discharge tube penetrating wall of host hypha; 20, 21, thalli in hyphae of host; 22-24, small thalli bearing resting spores. 25, 26, *Nowakowskiella atkinsii*, sp. nov.: 25, Thallus bearing three discharged sporangia; 26, portion of thallus bearing a mature sporangium and one discharging its zoospores. (Figs. 15, 30, 21, × 225; Figs. 16–24, ×330; Figs. 25, 26, × 650.)

late zoospores escaping through one or two discharge pores.

Saprophytic on snakeskin used as bait, in soil from a tomato field, 3 miles east of Santo Domingo; grass leaves used as bait, in soil from rocky field, 4.5 miles east of Santo Domingo; snakeskin bait, in soil from edge of canefield 7.8 miles north of Cienfuegos on Palmira road; Las Villas Province, Cuba, April 15, 1949.

The above description includes the measurements given by Miss Whiffen from her Texan material. In the Cuban fungi the very rarely formed zoosporangia (Fig. 30) ranged from 55 to 70μ in length by 22 to 25μ in greatest diameter and formed a lateral as well as an apical discharge pore. Occasionally, the container of the resting spore bore an apical papilla (Fig. 27).

Although *Blastocladiopsis parva* approaches in thallus structure (Fig. 29) certain species of *Blastocladia*, it is distinct from members of that genus in several particulars. The resting spores are completely smooth walled and do not possess the characteristic punctations found in species of *Blastocladia*. Furthermore, the spores lie loosely in their containers rather than filling them as in *Blastocladia*, and, lastly, the zoosporangia form up to six discharge tubes rather than a single apical one. Other features such as the formation of dwarf thalli (Fig. 28), rapidity of development, etc., will be discussed in another paper.

Aphanodictyon Huneycutt

Mycelium of limited extent, composed of delicate, moderately branched hyphae; gemmae not observed. Zoosporangia borne at the tips of lateral branches of the hyphae, rarely intercalary; wall of the zoosporangium evanescent; the zoospores encysting in position within the sporangium each later emerging through a pore from its cyst, the cysts remaining clustered at the hyphal tip; zoospores of the laterally biflagellate type. Oogonia terminal, bearing 3–5 eggs; walls unpitted. Antheridia present and functional. Oospores with eccentric globules; germinating by a hypha terminating in a sporangium.

Aphanodictyon papillatum Huneycutt

Aphanodictyon papillatum Huneycutt, Journ. Elisha Mitchell Sci. Soc. **64**: 279, 1948.

Mycelium delicate; hyphae sparingly branched, the main components about 5μ in diameter. Zoosporangia clavate, occasionally nearly cylindrical, terminal on lateral branches along the hypha, rarely intercalary, 13–70μ long by 12–18μ in greatest diameter, forming a false net after emergence of the zoospores; the zoospores reniform, 6–9μ by 4–7μ, with granular contents. Oogonia at first spherical, becoming irregular in shape at maturity; bearing numerous broad papillae; wall unpitted; bearing 3–5 somewhat spherical eggs 18–25μ in greatest diameter. Antheridia androgynous or occasionally diclinous as well, one or two on an oogonium. Oospores irregularly spherical 18–25μ in diameter with a thickened wall and eccentric globule; germinating soon after formation by a hypha which terminates in a zoosporangium.

Saprophytic on snake skin bait in soil from the finca "La Esperanza," Palmas, Matanzas Province, Cuba (coll. Angel Valiente), April 17, 1949.

Aphanodictyon is distinct from all Saprolegniaceae with spores encysting within the sporangium in the great delicacy of its vegetative growth, the mycelial mass being barely visible to the naked eye. Furthermore, the zoosporangia (Figs. 8, 9) are borne on short lateral branches along the delicate main hyphae and do not terminate the hyphae or renew growth by cymose branching as in related genera. The sexual apparatus (Fig. 10–14) resembles that of *Thraustotheca*, especially *T. primoachlya* Coker and Couch. Since the species has been reported only once, it seemed desirable to include a rather complete diagnosis. The Cuban material differs significantly from Huneycutt's in having moderately rather than excessively thick oospore walls.

Lagenidium destruens, sp. nov.

Thallus irregulariter dactylomorphus ramis variabilibus brevibus in plexum contortis interdum plenas partes hospitis infectas valde hypertrophas implens, sporangium unicum proveniens. Zoosporae numerosae reniformes, 12μ longae, 8μ crassae, lateraliter biflagellatae per tubam ex hospite extrusae ut massa amorpha, demum maturantes. Sporae durantes non sexualiter derivatae seriatim in thalli ramis, subrectangulares vel subellipsoidales, 10–15μ longae, 8–12μ crassae, globulos olei numerosos ferentes; membrana crassa. Germination nondum observata.

Parasiticum in hyphis et partibus reproductivis Achlyae sp. in solo sterili ex saxo serpentino derivatum in planitiebus prope portum navium aeriarum oppidi Sanctae Clarae, in provincia "Las Villas," Cuba, 24 Mar., 1949.

Thallus consisting of a complex of short, fingerlike irregular and contorted branches of variable size which may fill the strongly hypertrophied host parts; forming a single zoosporangium. Zoospores variable in number, reniform, 12 by 8μ, laterally biflagellate, ejected in an amorphous mass from the discharge tube to the outside of the host where maturation is completed. Resting spores asexually formed in a series in branches of the thallus, rectangular or somewhat ellipsoidal, 10–15 by 8–12μ, bearing numerous oil globules; wall thickened; germination not observed.

Parasitic in hyphae and reproductive organs of *Achlya* sp., in soil from serpentine savanna country just west of the Santa Clara airport, Las Villas Province, Cuba, March 24, 1949.

This species is remarkable for its virulence as a parasite. All parts of the host were invaded and destroyed within a few days. Both zoosporangia (Fig. 19) and resting spores (Figs. 22–24) were formed almost simultaneously.

In early stages of thallus development pronounced hypertrophy of the host is evident even though the parasite itself may be wholly or partially masked by the dense contents of the infected part (Figs. 15, 20, 21). Cross walls may or may not be laid down by the host to wall off infected areas. Thalli converted into zoosporangia discharge their contents through a short tube to the outside where the mass, apparently without an enveloping vesicle, rapidly becomes converted into biflagellate zoospores (Figs. 16–18). Other thalli by cleavage of their protoplasm into uniform sized irregular blocks produce asexually the thick-walled resting spores which undoubtedly survive during periods of drought.

L. destruens differs from all other 1-celled, saccate species of the genus in the extraordinary complexity of thallus development, resting spores and fungus host.

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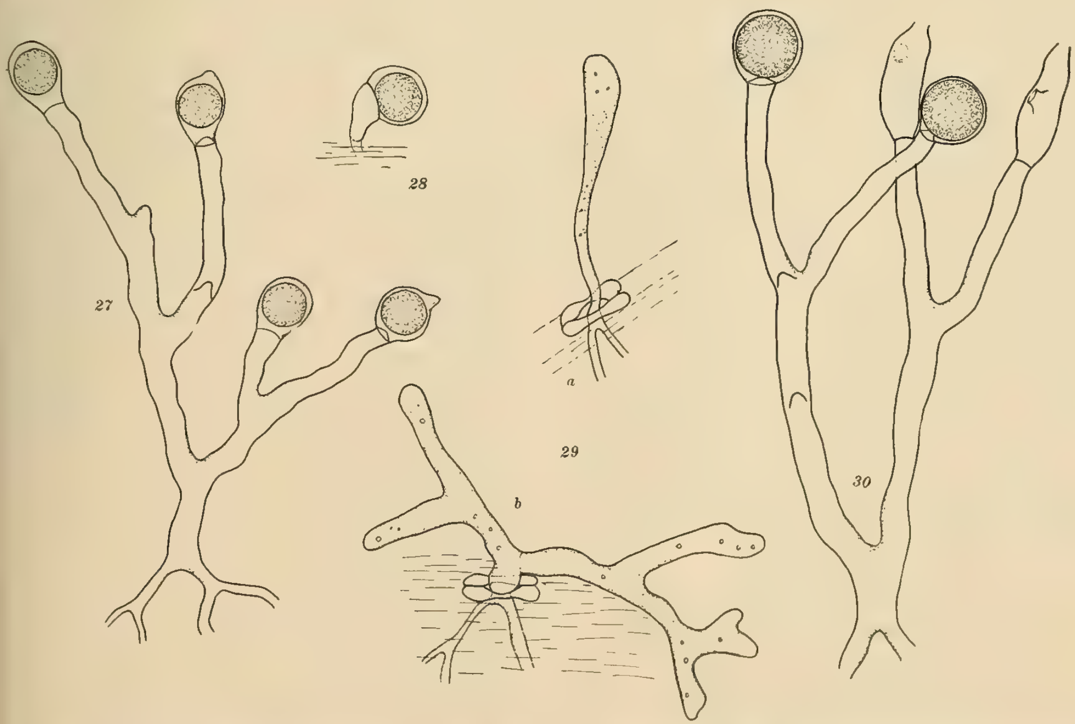

FIGS. 27–30.—*Blastocladiopsis parva*, comb. nov.: 27, Plant bearing papillate resting spore containers (note suppressed branches); 28, dwarf plant consisting of a few rhizoids in substratum a short basal cell and single resting spore; 29*a*, young plant emerging through stoma of grass substratum; 29*b*, older plant; 30, thallus bearing two resting spores and two cylindrical sporangia, each with two discharge pores. (All × 225.)

ZOOLOGY.—*Nemerteans from Antarctica and the Antarctic Ocean.*[1] WESLEY R. COE, Scripps Institution of Oceanography. (Communicated by F. A. CHACE, Jr.)

The collections of the United States Navy Antarctic Expedition in 1947–48 contained 75 specimens of nemerteans. These were dredged at several stations or collected along the shore of one of the islands in Marguerite Bay, Antarctica, near Peter I Island, Ross Island, and Cape Ross, by F. C. Nutt. Marguerite Bay is between Alexander I Island and Adelaide Island (68°–69°S., 68°–70°W.). It has a depth of 70 to 80 meters at the stations where the nemerteans were dredged. The collections indicate that the bay has a rather abundant nemertean fauna in spite of a water temperature of -1°C. or lower.

Although the collection includes only those species that have been previously described from the Antarctic region, the known geographical range is hereby extended and additional information relative to the morphological characteristics of the species has become available.

The species represented have been identified as: *Lineus corrugatus* McIntosh, 54 specimens; *Amphiporus gerlachei* Bürger, 1 specimen; *A. spinosus* Bürger, 1 specimen; *Tetrastemma amphiporoides* Bürger, 7 specimens; *T. validum* Bürger, 12 specimens. These specimens are deposited in the U. S. National Museum.

Order PALEONEMERTEA

No representatives of this order were obtained by the Navy Expedition, and only two species have been reported from Antarctic regions. These are *Carinina antarctica* Bürger, 1904, and *C. mawsoni* Wheeler, 1940.

Order HETERONEMERTEA

Lineus corrugatus McIntosh, 1887

Cerebratulus corrugatus Hubrecht, 1887; *C. steinini*, *C. subtilis*, *C. validus* Bürger, 1893; *C. charcoti* Joubin; *C. autrani* Joubin, 1908; *L. corrugatus* Baylis, 1915; *L. corrugatus* Wheeler, 1934, 1940.

This species is so highly variable both in form and color that it is not surprising that the varieties were formerly considered to represent separate species. The worms are capable of an unusual degree of extension and contraction in life and on being placed in preserving fluid contract into a great variety of shapes. Consequently shape of head and length of cephalic grooves, as well as position and size of mouth, offer little evidence as to their specific identity. As a result, several different names have been given to the preserved specimens in the different collections. The species has usually been placed in the genus *Cerebratulus*, but the study of many living individuals by Wheeler (1934) proves that they have the essential characteristics of *Lineus.*

Colored figures of the living worms published by Wheeler show that the body is smooth and moderately flattened and elongated in life, although the preserved specimens are often so conspicuously wrinkled as to have justified the species name *corrugatus.*

The color in life varies in many shades of gray, pink, brown, and dark reddish brown or black; ventral side paler. A pair of white vertical bands is usually more or less conspicuous near the posterior ends of the cephalic grooves. Region of proboscis opening and borders of cephalic grooves pale gray or white. Similar in most respects to *Lineus magelhaensicus* but differs in lacking ocelli.

Individuals of this species often reach a size greater than that of any other known nemerteans of the Antarctic region. The length may sometimes exceed 50 cm. when fully extended, and the width 3 mm. After preservation the body usually contracts to a small fraction of this length, but the width may be increased to 15 mm. The largest preserved specimen in the Navy Expedition collection was 90 mm long and 8 mm wide. Some specimens remain with relatively little contraction, with smooth bodies, narrowly pointed head and long cephalic grooves. More frequently, however, the body is so strongly contracted that the surface is roughly furrowed and corrugated, with the head withdrawn and the cephalic grooves correspondingly short.

Geographical distribution: This is evidently the most abundant and most widely distributed of all the Antarctic species. Wheeler (1934) collected several hundred specimens at South Geor-

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[1] Contributions from the Scripps Institution of Oceanography, new ser., no. 435. Received July 18, 1949.

gia, South Shetlands, South Orkneys, Anvers Island, East Falkland Island, and from dredge hauls at intermediate stations. The species was found from low water mark to a depth of 270 meters.

On the Navy Antarctic Expedition this species was collected at the following stations by D. C. Nutt: Off Cape Royds, Ross Island, January 29, 1948, 116 meters, 8 specimens; Marguerite Bay, February 22, 1948, 80 meters, 37 specimens; Marguerite Bay, February 20, 1948, 70 meters, 9 specimens.

The following additional representatives of this order have been reported previously from South Georgia, Falkland Islands, and from dredging stations in the South Atlantic and Antarctic Oceans: *Baseodiscus antarcticus* Baylis, 1915; *Parapolia grytvikenensis* Wheeler, 1934; *Lineus longifissus* (Hubrecht), 1887; *L. scotti* Baylis, 1915 (*L. roseocephalus* Wheeler); *L. magelhaensicus* Bürger, 1895; *Cerebratulus johnstoni* Wheeler, 1940; *C. larseni* Wheeler, 1934; and *C. malvini* Wheeler, 1934.

Order Hoplonemertea

Amphiporus gerlachei Bürger, 1904

A. gerlachei Wheeler, 1934.

The body is moderately slender and pink or rosy in color. Length of body 16 to 25 mm, width 2 to 3 mm. Bürger (1904) has published a colored figure of the living worm. Each side of the head is provided with two groups of large ocelli. The cerebral sense organs are large and are situated beside the brain. The armature of the proboscis consists of a relatively large, pear-shaped basis and 2 pouches, each containing 2 to 7 accessory stylets. There are 12 proboscidial nerves.

Geographical distribution: The specimen studied by Bürger was dredged near the ice shelf west of Charcot Island at a depth of about 500 meters. The considerable number examined by Wheeler (1934) came from depths of 161 to 208 meters in the vicinity of the Falkland Islands. The single specimen collected by D. C. Nutt on the Navy Antarctic Expedition was dredged at a depth of 80 meters near Marguerite Island. At all these localities the species was associated with *Lineus corrugatus*.

Amphiporus spinosus Bürger, 1893

A. spinosus Wheeler, 1934, 1940.

Examination of a large number of living individuals by Wheeler (1934) convinced him that this species is more variable morphologically than any other member of the genus at present known. Particularly variable are the number of pouches of accessory stylets in the proboscis and the number of proboscidial nerves. According to Wheeler's report, the accessory pouches in different individuals may vary from 2 to 22, with 1 to 3 stylets in each. If numerous, they may occupy the entire circumference of the proboscis. He found the number of proboscidial nerves to vary from 11 to 26.

The body is nearly cylindrical and may reach a length of 180 mm. The color in life is stated to be pale pink, pinkish red, brick red, or orange. Ocelli are minute but very numerous, occurring as a broad, dense patch on each side of head anterior to brain, with a few others scattered on dorsal side of brain region.

Wheeler (1934) concluded that the great variability in the proboscis armature is responsible for the several specific names that the species has been given by Bürger and Joubin. He has listed *A. spinosissimus* Bürger, *A. cruciatus* Bürger, and *A. multihastatus* Joubin as synonyms. Since in all the other known species of this genus there is relatively little variability in the proboscis armature, it may be suspected that further study of living material will prove that one or more of these names actually represent valid species.

Geographical distribution: The species has been collected over a wide area in the Antarctic. It was found in abundance among kelp holdfasts at South Georgia, and has been dredged at depths of up to 270 meters in the adjacent seas. One specimen was dredged by the Navy Antarctic Expedition off Cape Ross at a depth of 116 meters, January 29, 1948.

Tetrastemma amphiporoides Bürger, 1893

This species was first described by Bürger (1893) from South Georgia but was not mentioned by Wheeler (1934). Seven specimens were obtained by the Navy Antarctic Expedition. Each of these is about 20 mm long and 3 mm in width. The body is slender and flattened, with four large ocelli on the head. Bürger describes the color in life as dark violet dorsally and orange on ventral surface. In color the species is similar to *T. validum*, but the shape of body, general appearance, and internal anatomy differ. The armature of the proboscis consists of a conical basis, of approximately equal length to the sharply pointed central stylet, and two pouches with usually four stylets in each. There are 10 or 12 proboscidial nerves.

Geographical distribution: Dredged by the Navy Antarctic Expedition near Peter I Island at a depth of 60 meters by D. C. Nutt, February 15, 1948. Previously known only from the island of South Georgia.

Tetrastemma validum Bürger, 1893

T. validum Wheeler, 1934, 1940.

In form and color this is one of the most easily recognized of all species of nemerteans. The body is short and stout; rounded dorsally and flattened ventrally. The head is acutely pointed and separated from body by transverse lateral grooves. Color of dorsal surface is dark brown, with tinge of red, yellow, or purple. Ventral surface white, pale gray, pinkish or yellowish. In region of cephalic grooves the pale color of ventral surface extends dorsally to form a pair of conspicuous white lateral markings. These markings are broadly oval when body is extended but become sharply pointed dorsally when contracted. The internal anatomy is described in detail by Wheeler (1934), with a colored figure showing the characteristic markings of the living worm.

Twelve specimens of this species were collected by D. C. Nutt along the rocky shore of an island in Marguerite Bay. These specimens varied from 5 to 24 mm in length after preservation, although some of the living individuals mentioned by Wheeler (1934) were 35 to 40 mm long and 2.5 mm in width.

Geographical distribution: This is evidently a common species in the Antarctic region, for it has been collected also in Bransfield Strait, South Shetlands, at a depth of 200 meters, and in shallow water in the Palmer Archipelago, as well as near King Edward Cove, South Georgia (Wheeler 1934). Bürger first described the species from South Georgia.

The following additional representatives of this order have been reported from South Georgia, Falkland Islands, and the Antarctic region:

Amphiporus falklandicus Wheeler, 1934.
  inexpectatus Wheeler, 1934.
  lecointei Bürger, 1904.
  marioni Hubrecht, 1887.
  moseleyi Hubrecht, 1887 (*A. racovitzai* Bürger).
  schollaerti Wheeler, 1934.
  scoresbyi Wheeler, 1934.
Tetrastemma antarcticum Bürger, 1893.
  duboisi Bürger, 1893.
Tetrastemma esbenseni Wheeler, 1934.
  georgianum Bürger, 1893.
  gulliveri Bürger, 1893.
  hansi Bürger, 1893.
  longistriatum Wheeler, 1934.
  maivikenensis Wheeler, 1934.
  stanleyi Wheeler, 1934.
  unilineatum Joubin, 1910.
  weddelli Wheeler, 1934.
Nemertopsella marri Wheeler, 1940.
Drepanophorella tasmani Wheeler, 1940.

It will be observed that among these 35 species at present known from the Antarctic, the only representatives of the Paleonemertea are 2 species of *Carinina*, although the Heteronemertea are represented by 9 species and the Hoplonemertea by 24 species. In comparison, there are 53 species recorded from the Atlantic coast of North America, of which 5 are paleonemerteans, 19 heteronemerteans, 28 hoplonemerteans, and 1 bdellonemertean. On the Pacific coast of North America there are 98 known species; 11 of these are paleonemerteans, 37 heteronemerteans, 49 hoplonemerteans, and 1 bdellonemertean. The Antarctic nemertean fauna therefore does not differ widely from that of other regions, for with one exception the genera are identical and the proportionate representation of the species among the orders is in reasonably close agreement. All the species, however, appear to be peculiar to the Antarctic.

Although the temperature of the water remains below 0° C. even in midsummer in some of these areas, the nemertean population is almost as large and the mature individuals of approximately the same size as in related species living in regions of more moderate temperature.

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ZOOLOGY.—*A new precious coral from North Borneo.*[1] Frederick M. Bayer, U. S. National Museum. (Communicated by Fenner A. Chace, Jr.)

The Octocorallia collected during the Philippine cruise of the U. S. Fish Commission steamer *Albatross* have as yet not been reported upon, but preliminary studies indicate that the collection is one of great interest, and the number of species represented will probably be considerable. Although the collection contains only a single precious coral, it has proved to be new. In order to provide a complete key to the Indo-Pacific Coralliums for another report in preparation, it becomes necessary to describe it at this time, in advance of a complete report on the Philippine collection.

Although this new *Corallium* was obtained off North Borneo, not a single specimen was secured in the nearby Philippine waters. The absence of precious corals from collections made in the Philippine Archipelago is probably due to the fact that tangles were not used in the dredging operations. Most species of *Corallium* inhabit rocky ground where standard dredges and trawls are ineffective in securing fixed organisms. Seale (1911, p. 305; 1917, p. 204) states that a few small specimens have been found on the beach at Mindanao; since several species are more or less abundant in Japan, and three are now known from the Moluccas and Borneo, it seems likely that *Corallium* will eventually be found more or less abundantly in the Philippine Archipelago.

Corallium borneënse, n. sp.

Diagnosis.—*Corallium* branched on all sides; axis solid, striated, round except at twig tips where it is **X**- or **Y**-shaped in cross section; autozooids large, wartlike, set singly or in small groups, usually clustered on twig tips; siphonozooids minute, surrounding autozooids; coenenchyma papillate. Spicules: smooth double clubs, 6-, 7-, 8-radiates and crosses in both rind and verrucae; small rods with simple warts in verrucae only. Color in alcohol: rind salmon, verrucae flame scarlet (Ridgway, 1886, pl. 7); axis white with pink center.

Type.—U.S.N.M. no 49325, Sibuko Bay, British North Borneo: off Si Amil Island north 74° west, 5.4 miles (4°17′40″ N., 118°57′42″ E.), 292 fathoms, fine sand and green mud, bottom temperature 44.3°F. (*Albatross* station 5584, September 27, 1909).

Description.—The type is 5.5 cm in height, possibly only a branch of a large colony. The main axis is about 9 mm in diameter near the base, decreasing to 3.5 mm at the top. About 15 mm from the base there is a round hole 3 mm in diameter leading to a cavity within the stem; at the base of a branch 6 mm above the first hole there is a small but deep pit not connected with the axial cavity. These deformities were probably caused by a polychaete commensal. The axis is obscurely striated, round except at the twig tips where is is **X**- or **Y**-shaped in cross section. Branches are given off on all sides of the stem, projecting at right angles or inclined a little upward. The large branches irregularly subdivide into thick, clavate twigs which bear at their ends clusters of several autozooids; the small branches are mostly simple and of about the same calibre as the secondary twigs of the large branches. The autozooid calyces are low warts about 2 mm in diameter; very few occur on the main stem, but on the branches they are numerous, appearing singly or in groups of two or three, well separated. Twigs and branches terminate distally in a group of autozooids. There appears to be no predominance of autozooids on any one side; calyces may occur all around, or along any side. The siphonozooids are visible as small warts with simple orifices, often of a lighter color than the surrounding coenenchyma, situated around the bases of the autozooid calyces. The surface of the coenenchyma is papillate, but the character of the minute verrucae remains to be determined; it is possible that they also are siphonozooids, but

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received September 6, 1949.

more likely that they are only cnidal papillae. Unfortunately, the material at hand is not sufficient to permit the sectioning necessary to determine the answer, nor to investigate the canal system.

In spiculation *Corallium borneënse* is quite distinct. In both coenenchyma and verrucae the predominant form is the "double club" (Fig. 1, *b*, *c*, *j–m*), a highly modified sexradiate spicule with two of the arms greatly enlarged, forming a coalescent pair of spheroids (the club "heads"), two arms unmodified (forming the "handles" of the clubs), and the remaining two arms rudimentary, sometimes reduced to an inconspicuous irregularity of the spicule surface. Less common are the radiate forms with six (Fig. 1, *i*, *o*, *p*), seven (Fig. 1, *g*, *n*), or eight (Fig. 1, *f*) arms (imperfect forms are frequent among the radiate sclerites, such as the malformed octoradiate shown on Fig. 1, *q*), and simple crosses. Small rods with conical processes (Fig. 1, *e*) occur only in the calyces; this form seems to be derived from the multiradiate type by suppression of the arms.

Corallium borneënse is highly colored, the coenenchyma being nearest to Ridgway's "salmon" and the verrucae darker, approximating "flame scarlet." The white axis has a pink center.

Remarks.—The genus *Corallium* breaks down

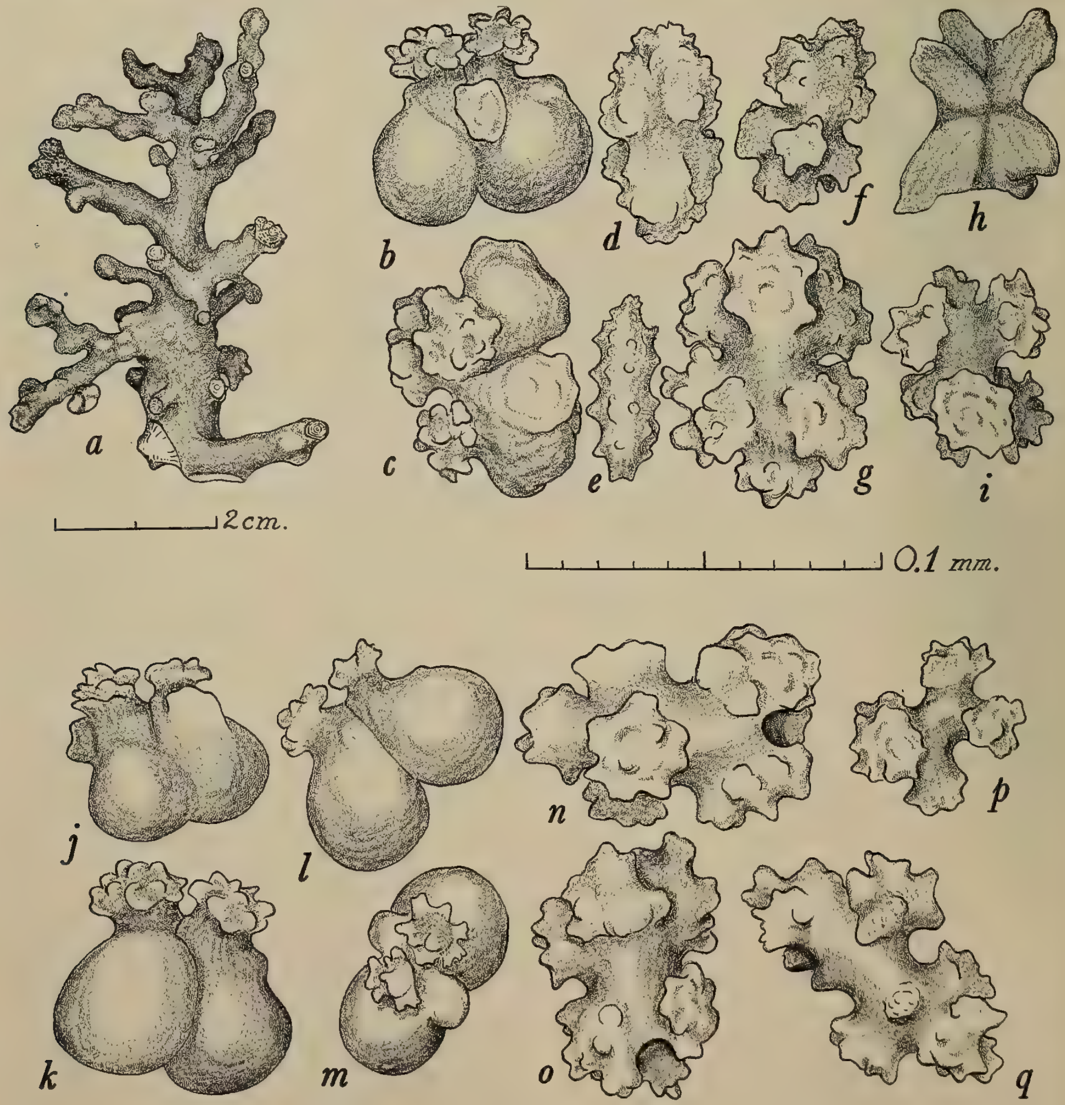

FIG. 1.—*Corallium borneënse*, n. sp.: *a*, Entire specimen; *b–i*, spicules from autozooid calyx; *j–q*, spicules from the coenenchyma.

on the basis of macroscopic features into four groups. (1) Those with the autozooids recessed into deep pits in the calcareous axis (e. g., *C. stylasteroides* Ridley). (2) Those with evenly distributed low, wart-like verrucae not appreciably recessed into the axis (e. g., *C. elatius* Ridley). (3) Those with high, tubular, sulcate calyces not recessed into the axis (e. g., *C. sulcatum* Kishinouye). (4) Those with rather large, dome-like verrucae often clustered in groups and also not set into the axis (e. g., *C. kōnojōi* Kishinouye). The new species just described falls into the fourth group, and except for the manner of branching is similar in appearance to *Corallium kōnojōi*. Microscopically the latter differs greatly in the predominance of sexradiates, the more irregular double clubs, and the presence of autozooids only on the "front" surface of the colony.

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SCIENCE PUBLICATION.—*Microfilms as publication*.[1] G. Winston Sinclair, University of Michigan. (Communicated by Richard E. Blackwelder.)

In June 1948 Aurèle La Rocque was graduated by the University of Michigan, doctor of philosophy in geology. Immediately after his graduation his doctoral thesis, *Pre-Traverse Devonian pelecypods of Michigan*, was sent (in accordance with the regulations of the Graduate School) to University Microfilms, a private organization located in Ann Arbor. They prepared a microfilm negative of the thesis and returned the typescript to the University Library, where it is preserved. A copy of the microfilm was sent to the Library of Congress, which catalogued it and distributed cards to depository libraries. Copyright was secured, in La Rocque's name. University Microfilms then distributed, as pages 116–117 of their *Microfilm Abstracts*, volume 8, part 2, an abstract of the thesis (prepared by La Rocque) and announced that copies of the complete thesis, identified as "University Microfilms Publication 1059," could be purchased from them at $2.88.

In this thesis La Rocque describes three new genera and 14 species of pelecypods. Are these names to be considered published in zoological nomenclature?

I have chosen this example to illustrate a situation that is becoming more common and on which taxonomists should have some agreed policy. The scope of the problem is indicated by the fact that the one agency mentioned, University Microfilms, has already "published" over 1,400 theses, originating in 14 colleges and universities. Most of these do not deal with zoological subjects, but some do, and more may be expected to be added each year. In order to provide background for intelligent discussion, it might be well to go into some of the details of procedure in microfilm publication.

Availability.—The test applied in deciding whether printed material has been validly published is: Are the results available to other workers? Two considerations arise here. The question of literal availability is easily answered. Any library or individual may purchase La Rocque's paper for $2.88, with no restriction on use or citation, apart from that implied in the fact that it is copyrighted. Availability, however, also implies

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[1] Received October 10, 1949.

that other workers know that the work exists and may be bought (or asked for). If I write a book, and distribute copies to my friends, then I have not published it, even though I might be glad to send a copy to a stranger if he should hear about it and ask for it. Sufficient public notice must be made to ensure that all potentially interested persons have a chance to learn of the work. University Microfilms' *Microfilm Abstracts*, essentially a publisher's catalogue in which the theses are priced and identified by a publication number, is distributed twice a year to about 450 libraries and abstracting agencies and is available to any library or institution wishing it. (A nominal price is set on this publication, but I understand that it is supplied to most libraries without charge.)

Edition.—A book publisher tries to estimate how many copies of a work will be needed, prints that number, and normally does not reprint it unless he has greatly underestimated the demand. This makes the size of the edition important, and a work of which very few copies were printed might be held to be invalid in nomenclature. The nature of microfilming demands new concepts. Since it costs no more, per copy, to make a microfilm copy tomorrow rather than today, there is no reason to make the 100th, or 500th, copy until someone orders it. If it is not asked for, then the expense of making it is saved. This means that if no orders are received for La Rocque's thesis, then University Microfilms' Publication 1059 has an edition of one, the one sent to the Library of Congress. But if 523 orders are received, then there is an edition of 524. And the edition is never closed, so long as the negative exists and some agency is willing to make copies of it.

Inconvenience.—Many workers are sufficiently old-fashioned (or sale-resistant) to object to microfilm except as an emergency tool in research. Since inconvenience in use is sometimes raised as an argument against acceptance of microfilm as publication, it should be mentioned that the publishers offer to provide a full-size copy of a whole paper, or selected parts (such as plates or illustrations), to anyone willing to pay the cost, 10 cents per page. Of course, this is expensive, but not much more so than the per-page cost of the Opinions of the International Commission on Zoological Nomenclature. The cost of the microfilm itself, $1\frac{1}{4}$ cents per page, would seem low enough to rule out objection on that score.

If in drawing up these notes I seem to be advocating acceptance of microfilmed work, it is simply because I find many taxonomists tend to shrug off any such suggestion without consideration. I hope that I have shown the problem as a real one. Three courses would seem open:

1. To decide that microfilm is not acceptable publication in taxonomy. Such a decision should be based on very careful consideration. The indefinite size of the edition would seem, to me, to afford the soundest grounds for objection.

2. To decide that microfilming is a valid means of publishing taxonomic material. This would mean treating each microfilming agency as we would any new journal or serial, making sure that the abstracting journals in which we are interested see copies of relevant papers, having our libraries place continuing orders for work in fields which concern us, etc.

3. To consider microfilming a valid but undesirable means of publication, to be discouraged. Since the actual publishers have no interest in the contents of their publications, this would mean convincing individual university faculties that theses in which new taxonomic units are proposed should not be sent for microfilming. The responsibility for abstracting and review would remain.

I am asking the Joint Committee for Zoological Nomenclature for Paleontology in America to discuss the problem. This note is published in the belief that other groups will wish to join the paleontologists in considering it and eventually in arriving at a concerted opinion.

PROCEEDINGS OF THE ACADEMY

433d MEETING OF BOARD OF MANAGERS

The 433d meeting of the Board of Managers, held in the Cosmos Club on December 12, 1949, was called to order at 8:01 p.m. by the President, Frank H. H. Roberts, Jr. Others present were: F. B. Silsbee, H. S. Rappleye, F. G. Brickwedde, W. W. Diehl, F. M. Defandorf, W. N. Fenton, C. L. Gazin, F. E. Johnston, W. A. Dayton, Margaret Pittman, H. W. Hemple, H. G. Dorsey, F. M. Setzler, and, by invitation, H. E. McComb, Herbert Friedmann, J. L. Shereshefsky, and F. L. Mohler.

The President announced the appointment of Joseph M. Caldwell to serve the unexpired term of the late Frank Thone on the Committee on Encouragement of Science Talent to January 1951, and of Frank M. Setzler to serve Mr. Thone's unexpired term as representative on the Council of the American Association for the Advancement of Science, also to January 1951.

The Board approved the recommendation of the Committee on Meetings to hold the annual meeting of the Academy on Saturday, January 28, 1950, this to be a dinner meeting at Hotel 2400.

The Committee on Membership submitted the names of 11 persons for resident membership.

The General Chairman of the Committee on Awards for Scientific Achievement, W. A. Dayton, presented the results of the decisions of the various subcommittees and made the following three recommendations for the 1949 Academy Awards, which were unanimously accepted by the Board:

Biological Sciences: Dr. Edward G. Hampp, of the National Institutes of Health, in recognition of his original and fundamental contributions to the knowledge of diseases of the oral cavity, and particularly because of his being the first to isolate in pure culture *Borrelia vincentii*, thus making possible new approaches to the study of spirochetes.

Engineering Sciences: Dr. Richard K. Cook, of the National Bureau of Standards, in recognition of his distinguished service in acoustics and his method of absolute calibration of microphones.

Physical Sciences: Dr. John A. Hipple, of the National Bureau of Standards, in recognition of his distinguished service in advances in mass spectrometry and in the precise measurement of atomic constants.

Mr. Dayton informed the Board that members of his Committee had discussed the possibility of offering more than one award each year. He also suggested that the future chairman of the Award Committee be instructed to recommend an award each year for the biological sciences.

The Secretary reported that a check for $400 had been received from the American Association for the Advancement of Science to cover the two grants-in-aid recommended by the Committee on Grants-in-Aid for Research and approved by the Board at its meeting on November 14, 1949.

W. N. Fenton, Chairman of the Committee on the Index of the Journal, reported that the first seven volumes have been completely indexed and the cards turned in to Paul H. Oehser, who is immediately supervising the work. Miss Mary A. Bradley, the indexer, informed the Committee that she expected to have completed by the first of the year the first 15 volumes, as contracted.

The Secretary reported the following deaths: John Tucker, Jr., National Bureau of Standards, on November 20, 1949 (elected May 16, 1941); and Hobert C. Dickinson, formerly of the National Bureau of Standards, on November 27, 1949 (elected April 8, 1912; on retired list December 31, 1945).

Margaret Pittman read a proposal from B. J. Olson suggesting the possibility of scientific symposia being sponsored by the Academy and its affiliated societies. The Board recalled that a previous committee had considered holding such symposia but found that the cost of arranging for them and publishing the results would be more than the Academy could afford. The Board voted to refer this report to next year's Committee on Meetings for consideration.

The meeting adjourned at 9:23 p.m.

F. M. Setzler, *Secretary.*

𝔒𝔟𝔦𝔱𝔲𝔞𝔯𝔶

John Montgomery Cooper, head of the department of anthropology at Catholic University of America, died in Washington, D. C., on May 22, 1949, of coronary thrombosis. Father Cooper held a place in the hearts of American scientists that is unique for an anthropologist at least. There were many facets to the man's personality—priest, social worker, public servant, educator, organizer of learning, councillor to the foundations and learned societies, and confidant of the younger anthropologists. Others will recall generosity, charity, and a glorious sense of humor that enlivened the conference room, the lecture hall, and sessions with Indian informants. Children, Indians, and his colleagues loved him in that order.

The Coopers were an old Maryland family, and Father Cooper was a life-long resident of the Washington area. Born at Rockville, Md., October 28, 1881, son of James Joseph Cooper and Emma Lillie (Toulou), he prepared at Calvert Hall, Baltimore, for St. Charles College, and went on to the American College in Rome, Italy, where he took the Ph.D. (1902) and the S.T.D. three years later. Classical art and archeology formed his first scholarly interest.

Before joining the faculty of Catholic University in 1909, and concurrently 1905–1918, Father Cooper served as assistant pastor of St. Mathews Church, where he was active in boys' work. As a student he had been an avid boxer, and he gave up tennis much later. His record in social work led to the appointment as director of camp and community activities for the National Catholic War Council, 1918–1920.

For two decades his teaching was in the field of religious education. To this period may be assigned books published between 1923 and 1930, not to mention articles on theology, and a report on *Children's institutions* (1930).

An associate professor in 1923, within five years he was elevated to professor of anthropology in the sociology department, with a separate department in 1935. Cooper trained few graduate students in anthropology by some university standards, but his influence extended widely here and abroad. Many of the present generation of working anthropologists can recall his kind words about a first paper read before a professional meeting, and no contribution was too insignificant not to merit a handwritten note of cordial congratulation. Nor was he above going to the field with younger men and sharing methods of observation and interview.

When there were working jobs to do, Cooper did not shirk, and he got a fair share of *kudos*. The minute books of the Anthropological Society of Washington attest to his conscientious industry as secretary during five terms; he was president during 1930–32. The American Anthropological Association meanwhile made him its secretary and elected him president, 1940. Likewise, he was vice-president of the American Folklore Society, 1943; fellow of the American Association for the Advancement of Science, recipient of the Mendel Medal, 1939, and a monsignor of the Catholic Church, 1941.

Of the Catholic Anthropological Conference he was founder and director of its fortunes from 1926 until his passing. *Primitive man* (22 vols.) was Cooper's journal, as was the *Anthropological Series* of his university. Some 14 numbers have appeared, many of which were written, and all edited, by the man himself.

His contributions to science were of a high order. In compiling the *Analytical and critical bibliography of the tribes of Tierra del Fuego . . .* (1917), Cooper developed a method of cultural analysis and an interest in the marginal tribes of the world with which his name will remain associated. Anthropological scholarship has seldom since attained the level set in this first monograph. But he was no mere library scholar.

Field work took him repeatedly to the Algonquian hunters of the Canadian Northeast and among the Gros Ventre of the Northern Plains. He brought training in theology to the study of primitive religious culture, publishing studies of divination (1928) and the Supreme Being (1934); and he was attracted as well to such mundane topics as "Snares and Deadfalls" (1938) and to a critical examination of whether the family hunting territory system of the northern peoples is pre-Columbian (1939). Cultural history and the South American area reclaimed his attention in recent years. Two theoretical papers on areal and temporal aspects of South American culture and of the northern arboreal hunters were followed by five ethnographic contributious on South American hunters in volume 1 and four topical studies in volume 5 of the *Handbook of South American Indians.* He considered it a great joke on himself to be doing "games and gambling" and "stimulants and narcotics."

William N. Fenton.

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MATHEMATICS.—*Comments on the classical theory of integral equations.*[1]

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§1. INTRODUCTION

The purpose of this paper is to show how a large part of the theory of the symmetric kernel can be adapted to the unsymmetric case merely by introducing the concept of a characteristic pair. By this we mean a pair of functions, $f(x)$ and $g(x)$, not identically vanishing, which with a suitable value of λ satisfy the following pair of equations:

$$(1.1)\qquad \begin{aligned} g(x) &= \lambda \int_a^b f(y)K(y,x)\,d\alpha(y) \\ f(x) &= \lambda \int_a^b K(x,y)g(y)\,d\alpha(y). \end{aligned}$$

Here $K(x, y)$ is the generally nonsymmetric kernel which we assume to be continuous, and hence bounded, on the closed square $a \leq x \leq b$, $a \leq y \leq b$. The function $\alpha(x)$ is monotonic increasing (and nowhere constant) on the interval $a \leq x \leq b$.

The number λ corresponding to such a nontrivial solution of (1.1) is called a characteristic number of the kernel. It is clear that if λ is thus a characteristic number accompanying the pair $[f(x), g(x)]$, then λ^2 is a characteristic value in the ordinary sense of the symmetric iterated kernel with characteristic function $f(x)$ or $g(x)$, according to whether the symmetric iterated kernel is

$$\int_a^b K(x,\xi)K(y,\xi)\,d\alpha(\xi) \text{ or } \int_a^b K(\xi,x)K(\xi,y)\,d\alpha(\xi).$$

Erhard Schmidt has taken advantage of this fact in adapting his theory of the symmetric kernel to the unsymmetric case.[2] Our method, on the contrary, makes no use of the iterated kernel. We attack the problem directly by a method devised by Kellogg[2] for the symmetric case. We show that this method can be easily modified so as to fit also the unsymmetric case. We prove a maximum property of our characteristic numbers and function pairs and prove expansion theorems in a manner entirely analogous to the classical theory for the symmetric case.[2]

We use the following abbreviation throughout the paper:

$$(u, v) = \int_a^b u(x)v(x)\,d\alpha(x).$$

We recall also in this introductory section that the class of functions $f(x)$, which may be represented in the form

$$f(x) = \int_a^b K(x,y)\Phi(y)\,d\alpha(y) \text{ or } \int_a^b \Phi(y)K(y,x)\,d\alpha(y),$$

in which $(\Phi, \Phi) = 1$, is equicontinuous. This follows from the uniform continuity of $K(x, y)$ in the closed square if we apply Schwarz's inequality to the right member of the equality

$$f(x) - f(x') = \int_a^b [K(x,y) - K(x',y)]\Phi(y)\,d\alpha(y).$$

The fact that this same class of functions is

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[1] Received December 8, 1949.

[2] Cf. Literature Cited at end of paper.

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bounded is even more obvious. We make these remarks to justify our subsequent use of Ascoli's theorem in the application of Kellogg's method. They also serve for an immediate proof of the fact that the functions of any characteristic pair must be continuous, a fact we tacitly use in some of our subsequent proofs.

§2. ELEMENTARY PROPERTIES OF CHARACTERISTIC NUMBERS AND PAIRS

First, it is clear from (1.1) that zero cannot be a characteristic number, inasmuch as the characteristic pair $[f, g]$ must not vanish identically.

Although we hereby assume throughout the paper that K and α are real-valued functions of real variables, we temporarily consider the possibility that f, g, and λ may be complex-valued. We notice from (1.1) that, if f and g are a characteristic pair corresponding to a characteristic number λ, then f and $-g$ are a characteristic pair corresponding to the characteristic number $-\lambda$, and conversely. Hence there is no essential loss of generality, if we assume in the sequel, as we shall do, that λ always lies in the right half plane including, possibly, the axis of pure imaginaries.

Let $[f_1, g_1]$ *and* $[f_2, g_2]$ *be two characteristic pairs corresponding respectively to the characteristic numbers* λ_1 *and* λ_2. *Then, in any case,*

$$|(f_1, f_2)| = |(g_1, g_2)|, \tag{2.1}$$

and, if $|\lambda_1| \neq |\lambda_2|$, *we have zero for the common value of* (f_1, f_2) *and* (g_1, g_2).

Indeed, from

$$f_2(x) = \lambda_2 \int_a^b K(x,y) g_2(y)\, d\alpha(y),$$

we have

$$\begin{aligned}(f_1, f_2) &= \lambda_2 \int_a^b \int_a^b f_1(x) K(x,y) g_2(y)\, d\alpha(y)\, d\alpha(x) \\ &= \lambda_2 \int_a^b \left[\int_a^b f_1(x) K(x,y)\, d\alpha(x) \right] g_2(y)\, d\alpha(y).\end{aligned}$$

But, since the integral within the bracket is known to be equal to $\lambda_1^{-1} g_1(y)$, we have

$$(f_1, f_2) = (\lambda_2/\lambda_1)(g_1, g_2). \tag{2.2}$$

Interchanging the subscripts 1 and 2 and remembering that $(u, v) = (v, u)$, we also obtain $(f_1, f_2) = (\lambda_1/\lambda_2)(g_1, g_2)$. Hence, either $\lambda_2/\lambda_1 = \lambda_1/\lambda_2$, or else $(g_1, g_2) = 0$, and the italicized statement is proved.

We also can prove very easily that *no characteristic number can be complex with nonvanishing imaginary part.* For, suppose λ_1 were a complex characteristic number with characteristic pair $[f_1, g_1]$. Then, if the complex quantities conjugate to λ_1, f_1, g_1 be denoted respectively by λ_2, f_2, g_2, we see from (1.1) that λ_2 is a characteristic number with characteristic pair $[f_2, g_2]$. Moreover (2.2) holds, and, since both (f_1, f_2) and (g_1, g_2) are obviously positive, (2.1) shows that $\lambda_1 = \lambda_2$. Hence λ_1 is real as we wished to show.

The result of all this is that, from now on, we may assume the characteristic numbers λ to be real and positive and the characteristic pairs to be real.

There may be many linearly independent characteristic pairs $[f_i, g_i]$, $i = 1, 2, \cdots$, corresponding to a single characteristic number λ. It is readily seen from (1.1) that any linear combination of these f_i taken together with the same linear combination of the g_i will furnish a characteristic pair for the characteristic number λ. Furthermore the f's corresponding to the *same* characteristic number can be *orthonormalized* so that $(f_i, f_j) = \delta_{ij}$ and then from (2.2) it is seen that the corresponding g's are also orthonormalized. It is already clear that f's corresponding to *different* characteristic numbers are orthogonal to each other, and the same is true of the g's.

Let us now consider a finite number m of characteristic pairs $[f_i, g_i]$ with corresponding characteristic numbers λ_i, $i = 1, 2, \cdots$, which are not necessarily distinct. According to what has been said, we may assume that $(f_i, f_j) = (g_i, g_j) = \delta_{ij}$. Then Bessel's inequality applied to the kernel shows that

$$\begin{aligned}&\int_a^b [K(x,y)]^2\, d\alpha(y) \\ &\geq \sum_{i=1}^m \left[\int_a^b K(x,y) g_i(y)\, d\alpha(y) \right]^2 = \sum_{i=1}^m \frac{f_i(x)^2}{\lambda_i^2}.\end{aligned}$$

Whence, a further integration with respect to x yields

$$(2.3)\quad \int_a^b \int_a^b [K(x, y)]^2 \, d\alpha(y) \, d\alpha(x) \geq \sum_{i=1}^{m} \frac{1}{\lambda_i^2}.$$

Since the left member of this inequality is independent of m, it is clear that the number of characteristic numbers less than any fixed number must be finite. We can therefore assume that our notation is chosen so that $\lambda_1 \leq \lambda_2 \leq \lambda_3 \leq \cdots$. If there is an infinite number of characteristic pairs, the inequality (2.3) then shows that the λ's must tend to infinity rapidly enough to secure the convergence of

$$\sum_{i=1}^{\infty} 1/\lambda_i^2 \leq \int_a^b \int_a^b [K(x, y)]^2 \, d\alpha(x) \, d\alpha(y).$$

§3. EXISTENCE OF CHARACTERISTIC PAIRS

We first prove that every kernel that does not vanish identically has at least one characteristic pair.

We prove the following two theorems, of which the first is a special case of the second with $m = 0$:

THEOREM I. *Every kernel that is not identically zero has at least one characteristic pair and corresponding characteristic number.*

THEOREM II. *Let* $[f_1, g_1]$, $[f_2, g_2]$, $\cdots$, $(f_m, g_m]$ *be* m *orthonormalized characteristic pairs of the kernel* $K(x, y)$, *the corresponding characteristic numbers being* $\lambda_1, \lambda_2, \cdots, \lambda_m$. *Then either*

$$K(x, y) = \sum_{k=1}^{m} \frac{f_k(x) g_k(y)}{\lambda_k},$$

or else there exists at least one further characteristic pair $[f, g]$ *with corresponding characteristic number* λ, *such that*

$$(f_k, f) = (g_k, g) = 0, \quad k = 1, 2, \cdots, m.$$

Since Theorem I is a special case of Theorem II, we confine our attention to the latter. For this purpose, we define

$$K_m(x, y) = K(x, y) - \sum_{k=1}^{m} \frac{f_k(x) g_k(y)}{\lambda_k}.$$

Not every function $u_0(y)$ is orthogonal to $K_m(x, y)$ for all x, unless $K_m \equiv 0$. For, suppose $K_m(x_1, y_1) \neq 0$. Then the function $u_0(y) = K_m(x_1, y)$ is not orthogonal to $K_m(x_1, y)$, since the continuity of $K(x, y)$, and hence of $K_m(x, y)$, implies that

$$\int_a^b [K_m(x_1, y)]^2 \, d\alpha(y) > 0.$$

Moreover $u_0(y)$, as thus defined, also has the property of being orthogonal to g_i for $i = 1, 2, \cdots, m$. This is easily proved on the basis of the known formulas,

$$(g_k, g_i) = \delta_{ki} \quad \text{and } \lambda_i^{-1} f_i(x_1) = \int_a^b K(x_1, y) g_i(y) \, d\alpha(y).$$

Now then, suppose $u_0(y)$ be *any* function in L_2 (not necessarily $K_m(x_1, y)$) which is orthogonal to $g_1, \cdots, g_m$ but which is not orthogonal to $K_m(x, y)$ for all x. Let

$$n_0 = (u_0, u_0)^{\frac{1}{2}} > 0, \qquad \bar{u}_0(y) = n_0^{-1} u_0(y).$$

Since $\bar{u}_0(y)$ is also not orthogonal to $K_m(x, y)$, although it is orthogonal to $g_1, \cdots, g_m$, the function

$$(3.1)\quad u_1(x) = \int_a^b K_m(x, y) \bar{u}_0(y) \, d\alpha(y) = \int_a^b K(x, y) \bar{u}_0(y) \, d\alpha(y),$$

does not vanish identically. Let

$$n_1 = (u_1, u_2)^{\frac{1}{2}} > 0, \qquad \bar{u}_1(y) = n_1^{-1} u_1(y).$$

We now give a formal inductive definition of a sequence, $u_i(y)$, $i = 0, 1, 2, 3, \cdots$ by means of the following equations:

$$(3.2)\quad u_{2s}(x) = \int_a^b \bar{u}_{2s-1}(y) K(y, x) \, d\alpha(y), \qquad s = 1, 2, \cdots$$

$$(3.3)\quad n_{2s} = (u_{2s}, u_{2s})^{\frac{1}{2}}, \qquad \bar{u}_{2s}(y) = n_{2s}^{-1} u_{2s}(y)$$

$$(3.4)\quad u_{2s+1}(x) = \int_a^b K(x, y) \bar{u}_{2s}(y) \, d\alpha(p), \qquad s = 0, 1, 2, \cdots$$

$$n_{2s+1} = (u_{2s+1}, u_{2s+1})^{\frac{1}{2}}, \tag{3.5}$$
$$\bar{u}_{2s+1}(y) = n_{2s+1}{}^{-1}u_{2s+1}(y).$$

Our first purpose is to prove by induction that this definition can be used to define an actual infinite sequence. Clearly the only way the definition can fail is for one of the numbers n_i to turn out to be zero. The definition would then fail to give $\bar{u}_i(y)$, and consequently would fail also to give all $u_j(y)$ for which $j > i$. We already know that n_0 and n_1 are not zero. It will therefore be sufficient to show that, when n_{i-1} and n_i are not zero, then n_{i+1} is also not zero. There are two cases to be considered according as i is odd or even.

Case I: i is odd, $i = 2l - 1$ ($l = 1, 2, 3, \cdots$). Our inductive hypothesis is to the effect that n_{2l-2}, n_{2l-1} (and indeed all prior n's) are not zero. We wish to prove that n_{2l} is also not zero. Under our inductive hypothesis the quantity,

$$(u_{2l}, \bar{u}_{2l-2})$$
$$= \int_a^b \left[\int_a^b \bar{u}_{2l-1}(y) K(y,x)\, d\alpha(y) \right] \bar{u}_{2l-2}(x)\, d\alpha(x),$$

is seen to have a meaning. Changing the order of integration, we see that

$$(u_{2l}, \bar{u}_{2l-2})$$
$$= \int_a^b \bar{u}_{2l-1}(x) \left[\int_a^b K(x,y) \bar{u}_{2l-2}(y)\, d\alpha(y) \right] d\alpha(x).$$

Hence, from (3.4) with s replaced by $l - 1$, we have

$$(u_{2l}, \bar{u}_{2l-2}) = (\bar{u}_{2l-1}, u_{2l-1}). \tag{3.6}$$

From Schwarz's inequality, we now find that

$$\begin{aligned} n_{2l-1} &= (n_{2l-1})^{-1}(u_{2l-1}, u_{2l-1}) \\ &= (\bar{u}_{2l-1}, u_{2l-1}) \\ &= (u_{2l}, \bar{u}_{2l-2}) \leq [(u_{2l}, u_{2l}) \\ &\quad \cdot (\bar{u}_{2l-2}, \bar{u}_{2l-2})]^{\frac{1}{2}} = [(u_{2l}, u_{2l})]^{\frac{1}{2}} = n_{2l}. \end{aligned} \tag{3.7}$$

Thus $n_{2l} \geq n_{2l-1} > 0$, which is what we wish to prove.

Case II: i is even, $i = 2l$ ($l = 1, 2, 3, \cdots$). Our inductive hypothesis is to the effect that n_{2l-1}, n_{2l} (and indeed all prior n's) are not zero. We wish to prove that n_{2l+1} is also not zero. The proof is entirely analogous to that given for Case I.

Omitting details, it is enough to say that from (3.2) and (3.4) we deduce

$$(u_{2l+1}, \bar{u}_{2l-1}) = (\bar{u}_{2l}, u_{2l}), \tag{3.8}$$

whence Schwarz's inequality yields the result

$$0 < n_{2l} \leq n_{2l+1}. \tag{3.9}$$

This completes the proof of the existence of the sequence. It also proves much more: namely, (3.7) and (3.9) combine to give

$$n_i \leq n_{i+1}, \qquad i = 0, 1, 2, \cdots \tag{3.10}$$

Moreover

$$\begin{aligned} n_i^2 = (u_i, u_i) &\leq [\alpha(b) - \alpha(a)] \text{ max. } [u_i(x)]^2 \\ &= [\alpha(b) - \alpha(a)] \\ &\qquad \max \left\{ \int_a^b K_i{}^*(x, y) \bar{u}_{i-1}(y)\, d\alpha(y) \right\}^2 \\ &\leq [\alpha(b) - \alpha(a)] \max \int_a^b (K_i^*(x, y))^2\, d\alpha(y) \\ &\qquad \cdot \int_a^b (\bar{u}_{i-1}(y))^2\, d\alpha(y) \\ &\leqq [\alpha(b) - \alpha(a)]^2 \max | K(x, y) |^2. \end{aligned}$$

Here we make use of Schwarz's inequality and $K_i^*(x, y)$ is used to represent either $K(x, y)$ or $K(y, x)$ according as i is odd or even. The last quantity written is independent of i. Hence the n's are bounded and, by (3.10), increase monotonically with i. Hence we may write

$$\lim_{i \to \infty} n_i = \mu > 0. \tag{3.11}$$

From the definition of n_{2l}, n_{2l-1}, we see that (3.8) can be written

$$\begin{aligned} &(u_{2l+1}, u_{2l-1})/n_{2l-1} \\ &\quad = (u_{2l}, u_{2l})/n_{2l} = n_{2l}. \end{aligned} \tag{3.12}$$

From Ascoli's theorem we know that there is a subsequence, $\{u_{2l-1},\}$ which tends uniformly to some function $f(x)$. From (3.2) and (3.4) it is obvious that the corresponding subsequences $\{u_{2l}\}$ and $\{u_{2l+1}\}$ must also converge uniformly to certain functions $g(x)$ and $h(x)$, respectively. Passing to the limit in (3.12) and using (3.11), we thus find that $(h, f) = \mu^2$ and likewise from (3.5) that $(f, f) = (h, h) = \mu^2$. Consequently $(h - f, h - f) = (h, h) - 2(h, f) + (f, f) = \mu^2 - 2\mu^2 + \mu^2 = 0$, from which it follows that the continuous functions h and f are identical. Thus, passing to the limit in (3.2) and (3.4), we have

$$g(x) = \mu^{-1} \int_a^b f(y)\, K(y, x)\, d\alpha(y),$$

$$f(x) = \mu^{-1} \int_a^b K(x, y)\, g(y)\, d\alpha(y),$$

and we have thus obtained a characteristic pair $[f, g]$ with characteristic number $\lambda = 1/\mu$. It remains to prove that this function $f(x)$ is orthogonal to $f_1(x), \cdots, f_m(x)$ and that $g(x)$ is orthogonal to $g_1(x), \cdots, g_m(x)$. This is done by first proving by induction that u_{2l-1} is orthogonal to $f_1, \cdots, f_m$, and that u_{2l} is orthogonal to $g_1, \cdots, g_m$. Starting with the known fact that u_0 is orthogonal to the g's, we find that

$$(f_i, u_1)$$
$$= \int_a^b \int_a^b f_i(x)\, K(x, y)\, \bar{u}_0(y)\, d\alpha(y)\, d\alpha(x)$$
$$= \lambda_i^{-1}(g_i, \bar{u}_0) = 0.$$

From this we find that

$$(u_2, g_i)$$
$$= \int_a^b \int_a^b \bar{u}_1(y)\, K(y, x)\, g_i(x)\, d\alpha(y)\, d\alpha(x)$$
$$= \lambda_i^{-1}(\bar{u}_1, f_i) = 0.$$

The reader may supply the formal details of the induction. The theorem follows at once by passing to the limit in the equations $(u_{2l-1}, f_i) = (u_{2l}, g_i) = 0$, which, on account of uniform convergence, yield $(f, f_i) = (g, g_i) = 0$. Theorems I and II have thus been completely established.

§4. AN EXTREMAL PROPERTY OF THE CHARACTERISTIC PAIRS AND NUMBERS

The same reasoning used in the preceding section also leads to the following important result.

THEOREM III. *If it is assumed that the notation for the characteristic pairs* $[f_i, g_i]$ *with corresponding characteristic numbers* λ_i *has been chosen (in accordance with* §2) *so that* $0 < \lambda_1 \leq \lambda_2 \leq \lambda_3 \leq \cdots$, *then*

$$(4.1) \quad \left| \int_a^b \int_a^b u(x)\, K(x, y)\, v(y)\, d\alpha(x)\, d\alpha(y) \right| \leq 1/\lambda_{m+1}, \; m = 0, 1, 2, \cdots$$

for any two functions $u(x)$ *and* $v(x)$ *such that* $(u, u) = (v, v) = 1$ *and either* $(v, g_i) = 0$ *or* $(u, f_i) = 0$, $i = 1, 2, \cdots, m$.

Assuming first that $(v, g_i) = 0$, $i = 1, 2, \cdots, m$, let $u_1, u_2, \cdots$, be defined by (3.1)–(3.5), in which we start with $\bar{u}_0(x) = v(x)$. Then, in accordance with what has been proved in connection with the preceding theorem, we know that $\lim_{i \to \infty} n_i = \mu$, where

$$(4.2) \quad n_i = (u_i, u_i)^{\frac{1}{2}} \leq \mu = \lambda^{-1}.$$

Here λ is a characteristic number corresponding to a characteristic pair other than the first m of them. Hence, in accordance with our present notation, $\lambda_{m+1} \leq \lambda$, and therefore (4.2) shows that

$$n_i = (u_i, u_i)^{\frac{1}{2}} \leq 1/\lambda_{m+1}, \qquad i = 1, 2, \cdots$$

But $J[u, v] = (u, u_1)$, where $J[u, v]$ is an abbreviation for the iterated integral in (4.1). Schwarz's inequality therefore yields

$$| J[u, v] | \leq (u, u)^{\frac{1}{2}} (u_1, u_1)^{\frac{1}{2}} = n_1 \leq 1/\lambda_{m+1},$$

and the theorem is proved in the case that $(v, g_i) = 0$ for $i = 1, 2, \cdots, m$. The other case evidently follows by symmetry.

It may be remarked that the upper bound for $J[u, v]$ given by the theorem is a maximum value to be attained by taking for u and v any characteristic pair having unit norms and belonging to the characteristic number λ_{m+1}.

Theorem III in the special case $m = 0$ leads to the following lemma:

LEMMA. *If* $u_1(x), u_2(x), \cdots, v_1(x), v_2(x), \cdots$ *are any two sequences of functions of class* L_2, *such that* $(u_i, u_i) \le M$, $(v_i, v_i) \le M$, *where* M *is a constant independent of* i, *and if* $J_n[u, v]$ *is defined to be an abbreviation for*

$$\int_a^b \int_a^b u(x) \left[K(x, y) - \sum_{k=1}^{n} \frac{f_k(x) g_k(y)}{\lambda_k} \right] \cdot v(y)\, d\alpha(x)\, d\alpha(y),$$

then $\lim_{n \to \infty} J_n[u_n, v_n] = 0.$

Here, as always in the sequel, the characteristic pairs $[f_i, g_i]$ are assumed to be orthonormalized. It is also assumed that the characteristic numbers λ_i are monotonically nondecreasing with, i and that there are infinitely many characteristic pairs. The corresponding theory for the finite or "degenerate" case is completely trivial.

PROOF: The characteristic pairs and corresponding characteristic numbers of the kernel,

$$(4.3) \quad K_n(x, y) = K(x, y) - \sum_{k=1}^{n} \frac{f_k(x)\, g_k(y)}{\lambda_k},$$

are obviously $[f_i, g_i]$, λ_i, $i = n + 1, n + 2, \cdots$. We now apply Theorem III with $m = 0$, with K replaced by K_n, with $u(x)$ replaced by $u_n(x)/(u_n, u_n)^{\frac{1}{2}}$, and with $v(x)$ replaced by $v_n(x)/(v_n, v_n)^{\frac{1}{2}}$, thus obtaining

$$(4.4) \quad \begin{aligned} J_n[u_n, v_n] &\le (1/\lambda_{n+1})(u_n, u_n)^{\frac{1}{2}}(v_n, v_n)^{\frac{1}{2}} \\ &\le M/\lambda_{n+1}, \end{aligned}$$

But since it is known from §2 that $\lim_{n \to \infty} \lambda_n = \infty$, the lemma is established. Strictly speaking the inequality (4.4) has only been established under the assumption that (u_n, u_n) and (v_n, v_n) are both not zero. But in the contrary case either $u_n(x)$ or $v_n(x)$ is almost everywhere zero and (4.4) is then trivial.

§5. THE FUNDAMENTAL EXPANSION THEOREM

In this section $F(x)$ denotes any function that can be represented in the form

$$(5.1) \quad F(x) = \int_a^b K(x, y)\, G(y)\, d\alpha(y),$$

where $G(y)$ is of class L_2 on (a, b). Such a function $F(x)$ is necessarily continuous. As before, the characteristic pairs $[f_i, g_i]$ are assumed orthonormalized, and the corresponding characteristic numbers are monotonically nondecreasing. We let $a_i = (F, f_i)$ and $b_i = (G, g_i)$. From Bessel's inequality, $\sum_{k=1}^{n} b_k^2 \le (G, G)$, we have the convergence of the series $\sum_{k=1}^{\infty} b_k^2$, and from the definition of the characteristic pairs we find that

$$\begin{aligned} (5.2) \qquad a_i &= (F, f_i) \\ &= \int_a^b \int_a^b f_i(x)\, K(x, y)\, G(y)\, d\alpha(y)\, d\alpha(x) \\ &= (g_i, G)\lambda_i^{-1} = b_i/\lambda_i . \end{aligned}$$

Using further the inequalities of Schwarz and Bessel and the fact that

$$\frac{f_k(x)}{\lambda_k} = \int_a^b K(x, y)\, g_k(y)\, d\alpha(y),$$

we find that

$$\begin{aligned} \left(\sum_{k=n}^{n+p} a_k f_k(x) \right)^2 &= \left(\sum_{k=n}^{n+p} \frac{b_k f_k(x)}{\lambda_k} \right)^2 \\ &\le \left(\sum_{k=n}^{n+p} b_k^2 \right) \left(\sum_{k=n}^{n+p} \left[\int_a^b K(x, y)\, g_k(y)\, d\alpha(y) \right]^2 \right) \\ &\le \left(\sum_{k=n}^{n+p} b_k^2 \right) \left(\int_a^b K(x,y)^2\, d\alpha(y) \right) \\ &\le \left(\sum_{k=n}^{n+p} b_k^2 \right) B^2 \left[\alpha(b) - \alpha(a) \right], \quad p = 1, 2, \cdots, \end{aligned}$$

where B is an upper bound for $K(x, y)$. The uniform convergence of the series $\sum_{k=1}^{\infty} a_k f_k(x)$ follows at once from the fact that the right hand member can be made arbitrarily small (on account of the convergence of $\sum_{k=1}^{\infty} b_k^2$) by taking n sufficiently large, independently of x. There is thus a continuous function

$$\Phi(x) = \sum_{k=1}^{\infty} a_k f_k(x).$$

If $\Phi_n(x)$ denotes the first n terms of this last series, we see from (5.1) and (5.2) that

$$F(x) - \Phi_n(x)$$

$$= \int_a^b K(x, y)G(y)\, d\alpha(y) - \sum_{k=1}^{n} \frac{b_k}{\lambda_k} f_k(x)$$

$$= \int_a^b K(x, y)G(y)\, d\alpha(y) - \sum_{k=1}^{n} \frac{(G, g_k)\, f_k(x)}{\lambda_k}$$

$$= \int_a^b K_n(x, y)\, G(y)\, d\alpha(y),$$

where K_n is given by (4.3). Multiplying by an arbitrary continuous function $w(x)$ and integrating, we have

$$(w, F - \Phi_n) = J_n[w, G],$$

where J_n is defined in the statement of the above lemma. Using this lemma and passing to the limit we find that $(w, F - \Phi) = 0$. This is true for any continuous function w. Hence, by taking $w = F - \Phi$, we conclude that the continuous functions F and Φ are identical. We formulate our result in the following theorem:

THEOREM IV. *Any function $F(x)$ that can be represented in the form indicated by* (5.1) *can also be represented as a uniformly convergent series of the form,*

$$\sum_{k=1}^{\infty} a_k f_k(x), \qquad a_k = (F, f_k).$$

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ANTHROPOLOGY.—*Separate migrations as an explanation of the physical variability among American Indians.*[1] GORDON R. WILLEY, Institute of Social Anthropology, Smithsonian Institution.

The assumptions underlying an explanation of physical variability among American Indians as the result of primary prehistoric movement from Asia are: (1) that considerable time (at least 25,000 years) was involved; (2) that migrant peoples passed into the New World by way of the Bering Straits; (3) that there were several principal migrations, each separated from the next by an appreciable time interval; and (4) that these groups of newcomers to the American scene reflect differences in the populations that were at that time living in northeastern Asia. It has been reasoned that once in the New World these successive waves of Asiatics distributed themselves throughout both continents, pushing southward along the Pacific coast or down the Mackenzie drainage to occupy North America and from there into the southern continent by way of Central America or the West Indies. Newer population waves, it is thought, had a tendency either to push aside or to compress into marginal areas those which preceded them, so that in time and space the earlier migrants eventually came to occupy either peripheral or, archeologically speaking, underlying positions. These premises have been carried to great lengths and detail by some (Dixon, 1923; von Eickstedt, 1933; Imbelloni, 1938a, 1938b) or advanced more cautiously by others (Stewart, 1940, 1943). The present paper is an examination and review of the possibilities of correlating selected variable physical characteristics among the American Indian with linguistic and cultural factors.

As implied in the title, our problem is one of isolating primary migrations from Asia to the New World. Within the Americas there is also the question of secondary migrations which might explain, historically, the geographical position of various groups of peoples; but I have not, in this brief paper, dealt with this aspect of the problem.

As the relative rates of change as among physical, linguistic, and cultural features are one of the fundamental unknowns of anthropology, we are not answering it here. It is obvious that any study, such as the present, operating as it does within three shifting frames of reference, the speed of whose shifts are unknown to us, is extremely vulnerable. It may indicate probabilities and point up problems, but it cannot offer proofs.

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[1] This paper was presented in a symposium on American Indian physical variability held on November 19, 1949, in New York City as a part of the annual meeting of the American Anthropological Association. Received November 23, 1949.

ASPECTS OF PHYSICAL VARIABILITY

Two sets of phycial characteristics to which anthropologists have attached genetic importance are expressed as the cephalic and cranial height indices (Dixon, 1923; Steggerda, 1932; Stewart, 1940, 1943; Newman, ms.). Without entering into the question of the stability or reliability of these indices in racial-historical studies, we shall proceed to examine their geographical distribution among the native peoples of the Americas. To do this the two indices have been paired into their four possible combinations. Each combination is reviewed in turn.

The combination of dolichocephaly and low-headedness is, apparently, the rarest of the four. In South America it is known principally from Tierra del Fuego and from the solitary, putatively early Punin calvarium; in North America it is somewhat more widespread, being present in the tribes of the northern Plains, in southwestern Canada, and in southern and lower California. The second combination, dolichocephaly and high-headedness, is more widespread. In North America it is prevalent throughout much of the Arctic, particularly on the earlier archeological horizons; it is standard for the northeastern Woodlands of the continent; and in the Southeast, the Mississippi Valley, and the southern Plains it generally characterizes the earlier prehistoric periods. The long and high head type is also found in the Southwestern United States, especially in the earlier cultural levels. Distribution of the type is spotty through Middle America, but in South America it prevails in the southern portion of the continent and in the interior of eastern Brazil where its antiquity can, seemingly, be traced back to Lagoa Santa man. The third type combination, brachycephaly and low-headedness, has its greatest concentration in the forest areas of northwestern South America and the Amazon Basin. There is some indication that this type is also found in the Maya region of Central America. Its North American distribution is rather rare. On the Aleutian Islands the later Aleuts are round low-heads, following the longer, higher-headed population on those islands. Some of the Northwest coast peoples are also round low-heads. The fourth combination, brachycephaly with high-headedness, is found throughout most of Andean South America, Middle America, and Mexico. To the north it dominates the later archeological horizons of the Southeastern and Southwestern United States and appears to some extent along the Northwest coast.

It is certainly not claimed that these four combinations of cephalic index and head-height index can be taken in their entirety as historical-racial groups. None of the four shows sufficient correlations with other physical characteristics to imply anything of this nature. The best that can be hoped for is that cranial proportions will offer some genetic clues to the history of peoples and culture in America. I believe that their significance is pointed up in an examination of the linguistic and cultural evidence.

LINGUISTIC AND CULTURAL CORRELATIONS

In attempting to correlate physical or racial traits with linguistics and culture we do not, of course, expect 100 percent correspondences. Relationships, if they existed, had a basis in historical association, not causality; and in the enormous time span involved these ancient associations have been constantly rearranging themselves in a network of vast complexity. The general coincidences, to which I shall refer are, of necessity, highly simplified abstractions.

It was noted that the long high-headed cranial type was especially dominant in Arctic and northeastern North America. This distribution of the dolichocephalic high-heads is approximately coextensive with two major linguistic stocks: Eskimo and Algonquian; and with two major cultural traditions: Eskimo and Woodland. Can these northern and northeastern long-heads be considered representative of a single Asiatic migration? The linguistic evidence would indicate two major migrations; the cultural evidence would back this up; and the racial evidence, although showing some close resemblances (Shapiro, 1931, 1933;

Seltzer, 1933), would verify a separateness between Algonquian and Eskimo. Thus, for our dolichocephalic high-headed type in North America there is a relatively strong case for at least two distinct invasions, or two series of invasions, from Asia. The Asiatic similarities to both Woodland and Eskimoan cultures are generally known (McKern, 1937; Spaulding, 1946; De Laguna, 1947; Larsen and Rainey, 1948) and substantiate such postulated migrations. Asiatic and Old World chronological estimates further suggest that these particular movements out of Siberia began no earlier then mesolithic times and continued to as late as the first century A. D. for some of the Eskimo.

Do these hypotheses account, even in a gross way, for all the northern and northeastern high-headedness and dolichocephals? We have remarked that high-headedness and dolichocephaly were not only characteristic of these parts of North America but that they were typical of the earliest cultural levels in both the northeastern and southeastern United States. Can these earliest long high-heads be considered as a part of the Algonquian-Woodland wave? This is a possibility, but there are a number of arguments against it. First, there is a chronological discontinuity in the physical type sequence. In New York, the old Archaic slightly built, long high-heads were impinged upon by a more rugged, round-headed people. Subsequently, dolichocephals reappeared who differed somewhat from the Archaic peoples. It is with this later group that Algonquian speech and Woodland culture can be definitely linked (Ritchie, 1944). Second, there are no Algonquian-speaking enclaves throughout the lower Southeast, a condition one might expect if the Archaic dolichocephals were of that speech group. And third, the slightly built high-headed dolichocephals of the Eastern Archaic are markedly similar to the geographically remote but comparably early Basketmaker skeletons of the Southwestern United States, a region without remnants of Algonquian speech or Woodland culture. In view of these considerations there is a strong indication that the earliest population of the Eastern United States was not a part of a somewhat later Algonquian invasion of North America. Instead, there is a countersuggestion that these early high-headed dolichocephals of the east were linked to a very early migration wave which included the ancient peoples of the southwest. These earliest long-heads were possessed of an "archaic-type" culture. (There are cultural similarities between Eastern Archaic and early southwestern Basketmaker.) It is impossible, however, to make a reasonable guess as to their linguistic affiliation.

Besides Eskimo and Algonquian there is another major linguistic stock of upper North America whose geographical position strongly suggests a relatively recent encroachment from northeast Asia. This is the Athapascan block, extending from interior Alaska into southern Canada with a detached enclave in Arizona, New Mexico, and Texas. Culturally, the northern Athapascans are divided between a Northwest coast and an inland tradition, both of which show Asiatic relationships. Ties to an old homeland are further emphasized by Sapir's suggestions of linguistic affinites to Sinitic tongues of east Asia (Jenness, 1940). Jenness (1940) is of the opinion that the Athapascans are the most recent comers of all, having passed through the Eskimo and pressed upon the Algonquian tribes. Racially, it is most pertinent to point out that Stewart's (1940) dolichocephalic and mesocephalic low-heads have a rough distributional correspondence to this putative Athapascan push. Northern and northwestern Plains tribes who border upon the northern Athapascans are similarly long and low-headed, but this could be readily explained as mixture with the new Athapascan physical type. It is of still further correlative interest to note that Blood Group A has its greatest North American occurrence in or near the area of the hypothecated Athapascan thrust (Boyd, 1939).

When we move south of Eskimo, Athapascan, or Algonquin territory, any case for physical-linguistic-cultural coincidences becomes much more difficult. Presumably, the more southerly located peoples have occupied the New World for a longer time; and, consequently, have had more opportunity to modify the cultural and linguistic heritage which they brought with them from Asia. It is generally assumed, for example, that the whole growth and diversification of the American agricultural civilizations occurred in the middle latitudes of the hemisphere long after the racial stocks who produced them had arrived in these continents. Trans-Pacific stimul :for Middle American or Peruvian cultures would not change this basic assumption.

The most striking racial-cultural configuration of Middle and South America is that the peoples of the high culture areas are predominantly high-headed brachycephals. The broad linguistic affiliations and migratory movements are not clear for this brachycephalic type. It appears in the later prehistoric period of both the southeastern and southwestern United States, and is associated in each of these regions with developed agricultural societies. On the northwest coast of North America, and elsewhere, round-headed people are associated with other types of culture. It is an open question as to whether the geographical distribution of North American brachycephalic high-heads results from secondary migrations out of Middle America or if it is simply a dispersement pattern following the primary movement out of the Old World. However, cultural evidence in the Southeast, and to some extent in the Southwest, seems to favor their late immigration into these United States regions from Mexico.

In South America the brachycephalic high-heads of the Andes are in contrast to the dolichocephalic high-heads of the Pampas, Patagonia, and the hinterlands of Brazil. The early chronological position of the dolichocephals, as in Lagoa Santa, together with the culturally and environmentally marginal conditions of other later long-heads, suggests that the type is an ancient population stratum for the continent. It is possible that there is a connection here with the Archaic and Basketmaker long high-heads of North America, although if such a link did exist there is no supporting cultural or linguistic proof of its former existence. Similarly, it is impossible to bring forth any linguistic or significant cultural evidence to support a migration connection between the dolichocephalic low-headed Fuegians of South America and the similar cranial type of north western North America. The same is true for the brachycephalic low-headed Arawakan and Caribban-speaking people of South America and the brachycephalic low-headed Aleuts of the north Pacific.

CONCLUSIONS

To summarize, cephalic and head-height indices of native American crania have geographical and chronological distributions in the two continents which suggest ancient differential migrations from the Old World. There are a number of general, although by no means perfect, correlations among these cranial data, the linguistic affiliations of the people involved, and their cultures. The best documented cross correlations are: (1) the dolichocephalic high-headed peoples of northeastern North America who, presumably, spoke an Algonquian tongue and possessed Woodland-type cultures; (2) the dolichocephalic high-heads of the far north, particularly the early arrivals in that area, who must have had an Eskimoan language and partook of the Eskimoan cultural tradition; and (3) the dolichocephalic and mesocephalic low-heads of northwestern North America who were Athapascan in speech and belonged either to the Mackenzie or Northwest coast areal traditions. All three of these groups have cultural ties to northeast Asia, and their generally northern position in the New World implies that they were the most recent migratory arrivals. I would estimate that either Eskimo or Athapascan were the latest, with the Algonquian preceding them.

In the American middle and southern latitudes it is more difficult to isolate physically differentiated peoples who are allied with specific cultural or linguistic types. High-headed brachycephals seem to be associated with the great centers of American agricultural civilizations, but no consistent linguistic correlations can be made here. Simple hunters and gatherers of east Brazil and southern South America show a high frequency of dolichocephally, but, again, there is no demonstrated linguistic unity. Possibly, these peoples are the descendants of an ancient long and high headed race who were among the first inhabitants of America. This possibility is suggested by their cranial similarity to early populations in the eastern and southwestern United States. Brachycephalic low-heads seem to conform to the South American Tropical Forest cultures and to Arawak, Caribbean, and neighboring languages, but there are no linguistic parallels to North America.

It is obvious that a successful matching of race, language, and culture, even on the broadest sort of basis, cannot be carried out for all parts of the Americas. Yet the correspondences which obtain among three major linguistic and cultural groups of northern North America are a strong argument for separate migrations from Asia as an explanation of the physical variability among these three. If this be accepted, then the probabilities are high that the physical, linguistic, and cultural diversity that confronts us farther to the south is at least in part explainable by separate and ancient migrations although we can no longer follow the multiple and complexly interwoven threads of the fabric.

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PALEONTOLOGY.—*Two new Lower Cretaceous lituolid Foraminifera.*[1] ESTHER R. APPLIN, ALFRED R. LOEBLICH, JR., and HELEN TAPPAN, U. S. Geological Survey and U. S. National Museum.

During the course of a study of the genus *Choffatella* in the subsurface Cretaceous of Florida, by Applin and Jordan, comparisons were made with forms that had been referred to this genus from the Walnut clay (Fredericksburg group) and the Glen Rose limestone (Trinity group) of Texas. A close examination disclosed that the Texas specimens were not true *Choffatella* and in fact represented two genera, neither of which could be referred to any previously described genus. These two genera and the type species are here described.

The material used in the present study was collected independently by Applin and by Tappan and Loeblich. Illustrations are camera-lucida drawings.

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[1] Published by permission of the Director of the U. S. Geological Survey and the Secretary of the Smithsonian Institution. Received November 9, 1949.

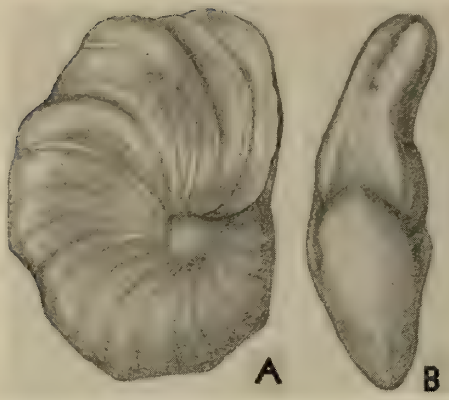

Fig. 1.—*Stomatostoecha plummerae* Applin, Loeblich, and Tappan, n. gen., n. sp.: A, Side view of holotype (U.S.N.M. no. 106219), showing numerous low chambers and raised and thickened sutures; B, edge view, showing lenticular, biumbonate test, and series of apertural pores at the peripheral margin of the apertural face. × 41.

Family LITUOLIDAE

Subfamily Endothyrinae

Stomatostoecha Applin, Loeblich, and Tappan, n. gen.

Genotype.—*Stomatostoecha plummerae* Applin, Loeblich, and Tappan, n. sp.

Diagnosis.—Test free, planispiral, not completely involute; chambers numerous; wall calcareous, imperforate, microgranular, with some additional detrital material incorporated in the epidermal layer, interior simple, not labyrinthic, and with neither transverse nor parallel partitions; aperture a single series of pores in a linear depression on the apertural face of the final chamber.

Remarks.—*Stomatostoecha* differs from *Choffatella* in the absence of any transverse or parallel partitions, although they are related, as shown by the planispiral character and similar apertures. *Stomatostoecha* differs from *Pseudocyclammina* in lacking the "labyrinthic" layer and from *Meandropsina* both in lacking the transverse and parallel partitions and in lacking the cyclical arrangement of chambers in the later stages. It differs from *Cyclammina* in the absence of a "labyrinthic" interior and in having a single row of apertural pores rather than numerous pores scattered over the apertural face.

Although both *Stomatostoecha* and the following new genus seem closely related to members of the Lituolinae, such as *Choffatella, Pseudocyclammina,* and *Cyclammina,* we have placed our new genera in the subfamily Endothyrinae because of the absence of a labyrinthic interior. They are apparently transitional between the Endothyrinae and Lituolinae, however.

Stomatostoecha plummerae Applin, Loeblich, and Tappan, n. sp.

Figures 1–3

Choffatella sp. aff. *C. decipiens* Schlumberger, Adkins, Texas Univ. Bull. 3232: 333. 1932.

Test free, large, planispiral, and involute in most specimens, although a few become somewhat evolute in the later stages, lenticular, biumbonate, periphery bluntly rounded; chambers numerous, low and broad, ranging from as few as 11 in small specimens to as many as 20 in the last whorl of large, well-developed specimens, as many as 2½ whorls commonly developed,

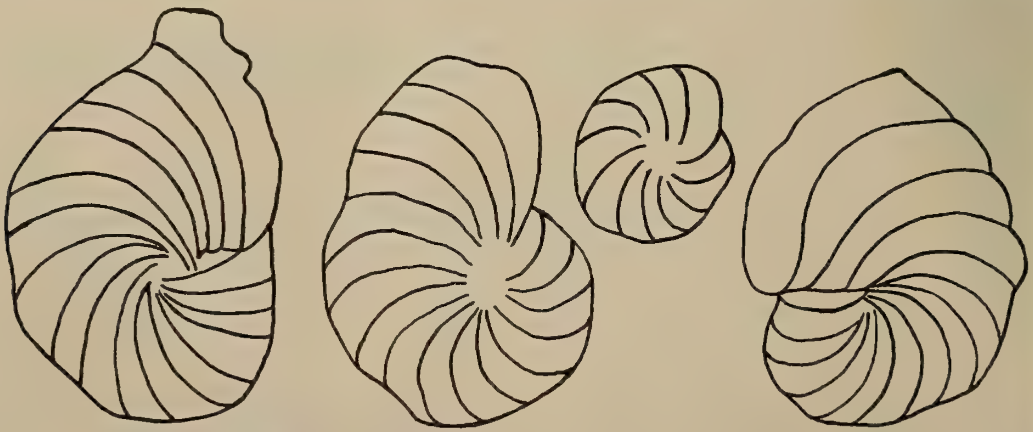

Fig. 2.—*Stomatostoecha plummerae* Applin, Loeblich, and Tappan, n. gen., n. sp.: Outline drawings of exterior of paratypes (U.S.N.M. nos. 106220a–d), showing variations in size and outline. × 41.

with the earlier whorls covered by the later chambers; sutures slightly curved, thickened and generally raised, at other times somewhat obscure; wall thick, calcareous, imperforate, microgranular, with some additional detrital material incorporated in the epidermal layer, the amount of agglutinated material varying somewhat with the nature of the enclosing sediments, interior simple, not labyrinthic, and with neither transverse nor parallel partitions; aperture a single series of pores in a linear depression on the apertural face of the final chamber, extending from the peripheral angle about one half the length of the apertural face.

Greatest diameter of holotype 1.20 mm, least diameter 0.94 mm, greatest thickness 0.36 mm. Other specimens range from 0.44 to 1.59 mm in greatest diameter.

Remarks.—In addition to the distinct generic characters mentioned above, the present species differs from *Choffatella decipiens* Schlumberger in being about one half as large and in being lenticular in section, rather than compressed.

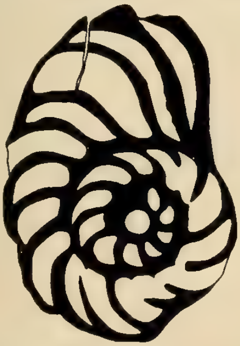

FIG. 3.—*Stomatostoecha plummerae* Applin, Loeblich, and Tappan, n. gen., n. sp.: Camera-lucida drawing of thin section of paratype (U.S.N.M. no. 106228), showing thickened walls and absence of accessory structures. × 48.

Although the Lituolidae are generally regarded as arenaceous in character,[2] the present writers agree with the conclusion reached by Henson[3] that many of the genera are essentially calcareous. In a discussion of the type species of *Choffatella*, Henson stated that "sections show that the walls contain very little arenaceous material, and in some specimens none at all is perceptible under the microscope; the essential nature of the shell material is calcareous, imperforate, and microgranular, but the tests rarely have that milky-white appearance which is characteristic of nonarenaceous, imperforate foraminifera. It is probable, therefore, that a certain amount of argillaceous impurity is contained in the interstices between the calcite crystals of which the walls are composed." The wall structure of the present new genera was studied under a petrographic microscope, and appeared granular, but there was no evidence of any agglutinated fragments except in the outermost layer, the calcareous material forming the largest portion of the wall.

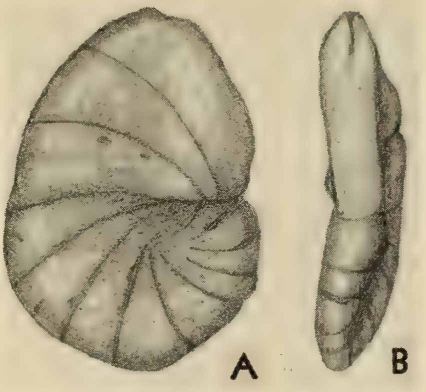

FIG. 4.—*Phenacophragma assurgens* Applin, Loeblich, and Tappan, n. gen., n. sp.: A, Side view of holotype (U.S.N.M. no. 106225), showing subovate outline, wedge-shaped chambers, and slightly evolute character; B, edge view, showing flattened form and short slitlike aperture at the peripheral angle. × 72.

Types and occurrence.—Holotype (U.S.N.M. no. 106219), figured paratypes (U.S.N.M. nos. 106220a–d), and unfigured paratypes (U.S.N.M. no. 106221) from the Walnut clay, just below the *Dictyoconus walnutensis* (Carsey) bed in a small quarry on the north side of the Hickmuntown-Mansfield Dam road, 1.6 miles by road southwest of Hickmuntown, Travis County, Texas, collected by A. R. Loeblich, Jr.; unfigured paratypes (U.S.N.M. no. 106222) from the Walnut clay, just below the *Dictyoconus walnutensis* (Carsey) ledge on the south side of Mount Barker, about 3.5 miles (air line) northwest of the Capitol Building in Austin, Travis County, Texas, collected by A. R. Loeblich, Jr., figured thin section (U.S.N.M. no. 106228) from E. R. Applin collection from the same locality; unfigured paratypes (U.S.N.M. no. 106223) from the Walnut clay, in a low exposure on the south side of the road, 0.6 mile by road west of the crossing of the Missouri

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[2] CUSHMAN, J. A., *Foraminifera, their classification and economic use*, ed. 4: 100. 1948.

[3] HENSON, F. R. S., *Larger imperforate Foraminifera of southwestern Asia:* 14. British Mus. Nat. Hist., 1948.

Pacific Railroad, on the Bull Creek road, northwest of Austin, Travis County, Texas, collected by Helen Tappan and A. R. Loeblich, Jr.; unfigured paratypes (U.S.N.M. no. 106224) from the Glen Rose limestone (zone of *Salenia texana*), 440 feet below the top, in a road cut on U. S. Highway 281, 1.2 miles north of the junction with Texas State Highway 46, Comal County, Texas, collected by A. R. Loeblich, Jr.

Phenacophragma Applin, Loeblich, and Tappan, n. gen.

Genotype.—Phenacophragma assurgens Applin, Loeblich, and Tappan, n. sp.

Diagnosis.—Test free, planispiral, somewhat evolute, with a slight tendency to uncoil; chambers numerous; septa of two types, the complete normal septa alternating with shorter partitions which project only slightly into the chamber cavities; wall calcareous, imperforate, and microgranular, with some additional material incorporated in the epidermal layer, interior simple, not labyrinthic, and with no transverse partitions; aperture slitlike, terminal, on the final chamber.

Remarks. — *Phenacophragma* differs from *Pseudocyclammina* in lacking the labyrinthic interior and cribate aperture and in possessing the short intercalary septa. It differs from *Stomatostoecha* in possessing the secondary septa and in having a single slitlike aperture, rather than a series of pores.

Phenacophragma assurgens Applin, Loeblich, and Tappan, n. sp.

Figures 4–6

Test free, large, ovate in outline, flattened, planispiral and slightly evolute, so that previous whorls may be seen in the umbilical region, later chambers tending to uncoil, periphery subacute; chambers numerous, from 12 to 15 present in the last whorl, about 2½ whorls usually developed, chambers low and broad; sutures straight or slightly curved, flush or slightly depressed, although occasional collapsing of the walls allows them to appear raised, the intercalary septa only about one third to one fourth as long as the other septa as seen in thin-sections, occasionally curved backwards, may at times be reflected externally

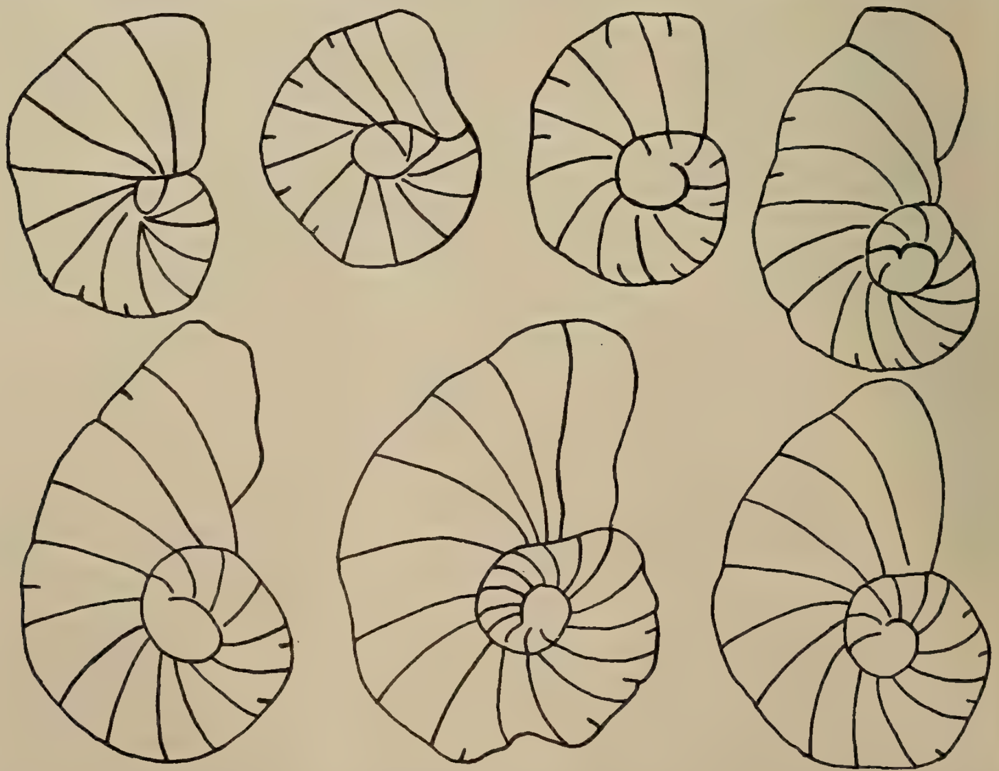

Fig. 5.—*Phenacophragma assurgens* Applin, Loeblich, and Tappan, n. gen., n. sp.: Outline drawings of exterior of paratypes (U.S.N.M. nos. 106226a–g), showing variation in size and outline, somewhat evolute test, tendency of the later chambers to uncoil, and occasionally visible intercalary septa. × 72.

although they are not as distinct as the normal septa when viewed from the exterior; wall calcareous, imperforate and micrograndular, with some additional material incorporated in the epidermal layer, interior simple, not labyrinthic, and with no transverse partitions; aperture at the peripheral angle, consisting of a single slit which extends a short distance down the apertural face.

Greatest diameter of holotype 0.65 mm, least diameter 0.49 mm, greatest thickness 0.16 mm. Other specimens range from 0.47 to 0.86 mm in greatest diameter.

Remarks.—In addition to the different generic characters enumerated above, this species may be distinguished from *Stomatostoecha plummerae*, n. sp. by its being slightly smaller, in being flattened rather than lenticular and biumbonate, and in having a more pronounced tendency to uncoil in the later stages. The chambers are less numerous, and are not as low and broad, but may even appear wedge-shaped, and the septa are much thinner and are straighter. *Phenacophragma assurgens* also differs from *Choffatella decipiens* Schlumberger in being about one third as large, in having less numerous chambers, and in lacking the labyrinthic interior and multiple aperture.

Types and occurrence.—Holotype (U.S.N.M. no. 106225), figured paratypes (U.S.N.M. nos. 106226a–g), and unfigured paratypes (U.S.N.M. no. 106227) from the Glen Rose limestone, 520 feet below the top, in a road cut on the east side of U. S. Highway 281, 2.4 miles north of the junction with Texas State Highway 46, Comal County, Texas, collected by A. R. Loeblich, Jr.; figured sectioned paratype (U.S.N.M. no. 106229) from E. R. Applin collection from the same horizon and locality.

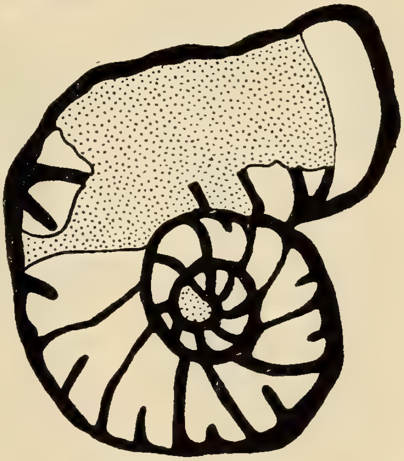

FIG. 6.—*Phenacophragma assurgens* Applin, Loeblich, and Tappan, n. gen., n. sp. Camera-lucida drawing of thin section of paratype (U.S.N.M. no. 106229), showing alternation of normal and intercalary septa and more delicate wall structure than in *Stomatostoecha plummerae*. × 95.

ENTOMOLOGY.—*Additional illustrations and notes on* Aedes bambusicolus *Knight and Rozeboom.*[1] EDWARD S. ROSS, California Academy of Sciences. (Communicated by ALAN STONE.)

Aedes (*Stegomyia*) *bambusicolus* Knight and Rozeboom[2] was described from one of two male specimens reared from a bamboo stump on Culion Island, Philippine Islands, June 20, 1945. The female, larva, pupa, and biology have not yet been described. During June 1945, the writer collected a small series of this species near San José, Mindoro, and secured adult-associated larval and pupal skins. In view of the remarkable nature of the early stages of the species, it seems desirable to publish the present illustrations and notes at this time.

Male.—Discrepancies in the terminali figure published by Knight and Rozeboom (pl. 10, fig. 8) and the one presented here (Fig. 1) will be noticed. These are apparently due to the fact that the former was drawn from a crushed slide preparation, which exhibits the various structures spread apart and the ordinarily dorsally directed inner setae of the basistyle in profile. The scales of the basistyle were also apparently intentionally omitted. My illustration is based on an uncrushed preparation and shows the various structures and inner setae in the true relation and perspective. These setae appear to be much shorter than they actually are because of the foreshortened representation. The disadvantage of each of these methods of mounting genitalia can be overcome by using the figures in a supplementary manner.

Not noted in the original description is a

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[1] Received October 29, 1949.

[2] KNIGHT, K. L., and ROZEBOOM, L. E. *The* Aedes (Stegomyia) albolineatus *group* (*Diptera, Culicidae*). Proc. Biol. Soc. Washington **59**: 94, pls. 9, 10. 1946.

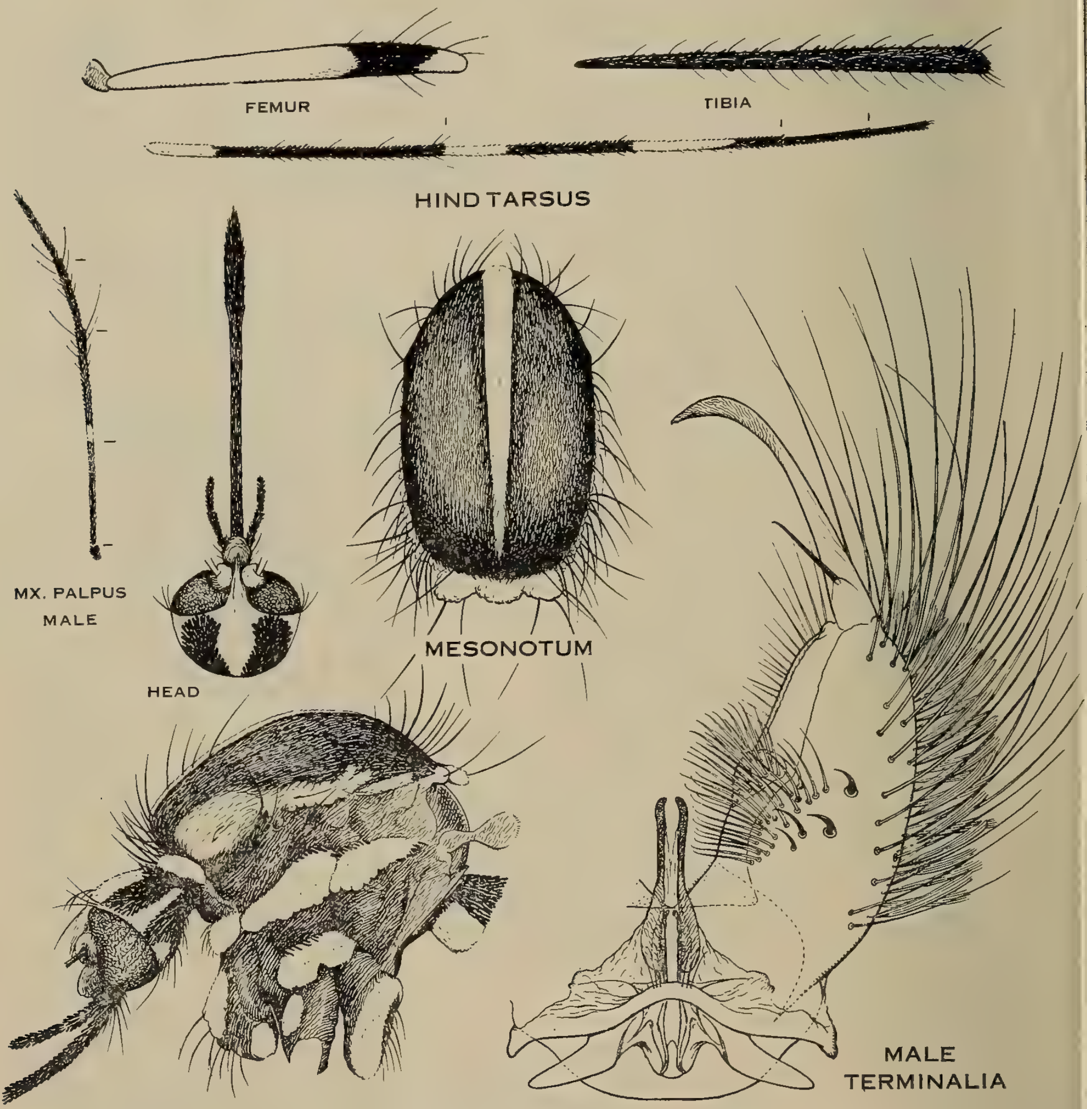

Fig. 1.—Adult characters of *Aedes bambusicolus* Knight and Rozeboom. (Unless otherwise stated, all drawings are based on a female.)

very narrow pale band at base of third palpal segment (see Fig. 1).

Female.—Certain salient features are illustrated in Fig. 1. The markings are almost identical to those of male.

Larva.—Very elongate, narrow; thorax scarcely wider than head. Colorless except for head and its appendages, which are pale straw-yellow; anal plate and air tube straw-yellow; sclerite at base of ventral brush, comb scales, and spiracular plates golden-yellow. Head form and dorsal chaetotaxy as figured (Fig. 2). Thoracic and abdominal integument smooth; hairs generally fine, poorly branched, lateral hairs golden-yellow. Terminal abdominal structures as figured (Fig. 2); comb scales generally four in number occasionally only three present, apices often forked, plate variable in shape; pecten teeth vary from one to four but usually three in number; sclerite at base of ventral brush characteristic, invariably present.

Pupa.—Abdominal chaetotaxy as figured (Fig. 2). Color pale golden-yellow throughout. Differs from all other *Aedes* pupae

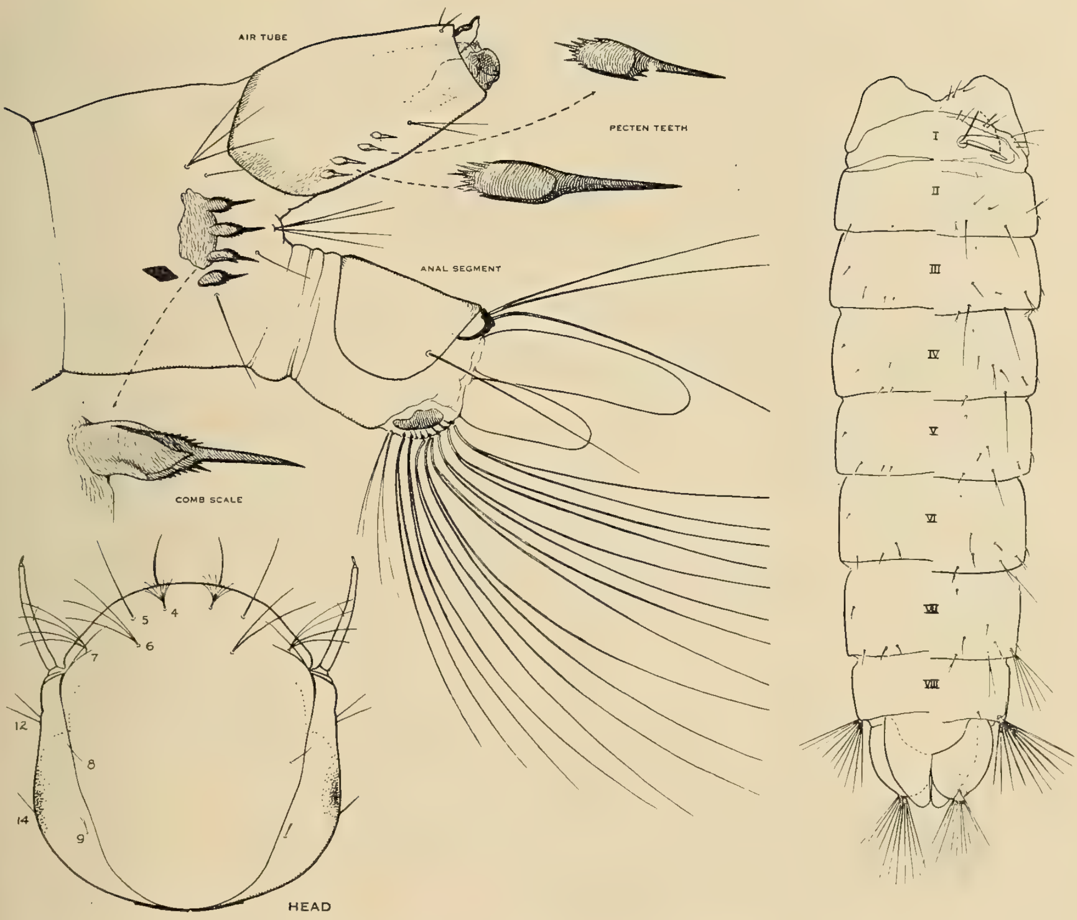

Fig. 2.—Larval characters and abdomen of pupa of *Aedes bambusicolus* Knight and Rozeboom. Left side of pupa ventral; right side, dorsal.

known to the writer in the great development of the paddle hair and enlarged genital sac of the male which is longer than the paddles. A preparation of a male pupa with the completely developed adult within shows that the terminal third of this elongation accommodates the long outer setae of the basistyle developing within. The genital sac of the female is, of course, much smaller than that of the male. The only parallel known to the writer to the greatly developed paddle hair has been figured by Edwards (fig. 162)[3] for *Eretmapodites quinquevittatus* Theobald. Here also the genital capsule (sex not stated) is relatively large but neither this nor the paddles are as large in relation to the abdomen as in *bambusicolus*.

Material examined.—Four males and three females were reared from two lots of larvae collected on June 10 and 14, 1945. Five adult-associated larval and pupal skins and six whole mounts of larvae were thus obtained. All are from a forest three miles southeast of San José, Mindoro. Specimens will be deposited in the U. S. National Museum and the California Academy of Sciences.

Biology.—Larvae occur in rather foul water in butts of freshly cut bamboo (1 to 2 inches in diameter) in the dark shade of primary forest. The activities, habitat, and general appearance of the larvae are reminiscent of those of certain species of *Armigeres*. They remain at the bottom of culture jars for prolonged periods vigorously probing the bottom muck in a manner quite unlike most species of *Stegomyia*. No observations were made on the habits of the adult. The species may be regarded as quite rare as it was encountered only twice during nearly a year of intensive collecting in the area. It is likely to be overlooked, however, as its larvae may be mistaken for those of certain species of *Armigeres* and its adults for certain other members of the *albolineatus* group.

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[3] Edwards, F. W. *Mosquitoes of the Ethiopian Region, III: Culicine adults and pupae:* 499 pp., figs. British Museum (Natural History), London, 1941.

ZOOLOGY.—*Recent species of the lucinoid pelecypod* Fimbria.[1]

David Nicol, U. S. National Museum.

The living species of *Fimbria* [*Corbis*] were reviewed by Lamy in 1921. Since that time no comprehensive study of the genus has been published, and only a few figures, lists, or brief descriptions of its species have been mentioned in Indo-Pacific faunal studies. The number of specimens of *Fimbria* at the U. S. National Museum has been greatly augmented by the shells collected at Bikini, and with this large amount of material it is possible to add to our knowledge of the genus.

Although the Fimbriidae are now a small family comprising only the genus *Fimbria* with two living species, during Jurassic and Cretaceous times it was well represented in number of species in warm and temperate seas all over the world. At the end of the Cretaceous and during all of the Tertiary, the geographic range of the family has slowly contracted until it is found now only in the warm waters of the eastern Indian Ocean and the western and central Pacific Ocean.

Family FIMBRIIDAE, new name

Genus **Fimbria** Megerle von Mühlfeld, 1811

Genotype: *Fimbria magna* Megerle von Mühlfeld, 1811 = *Venus fimbriata* Linné, 1758 (monotypy).
Venus Linné, 1758 (in part).
Lucina Bruguière, 1797 (in part).
Gafrarium Röding, 1798 (in part).
Corbis Cuvier, 1817. Genotype: *Venus fimbriata* Linné, 1758 (monotypy).
Idothea Schumacher, 1817 (not *Idothea* Fabricius, 1796). Genotype: *Idothea perforata* Schumacher, 1817 = *Venus fimbriata* Linné, 1758 (monotypy).

For the past hundred years the name *Corbis* has been used almost without exception. Most workers consider *Fimbria* Megerle von Mühlfeld, 1811, a junior synonym. Bohadsch, 1761, had used the name *Fimbria* for an udibranch, but recently his work has been suppressed by a suspension of the rules (Opinion 185, 1944); thus *Fimbria* Megerle von Mühlfeld can be used. If the law of priority is followed, *Fimbria* Megerle von Mühlfeld, 1811, must replace *Corbis* Cuvier, 1817. One other solution is to ask for another suspension of the rules in order to continue the use of the name *Corbis*. Some taxonomists have thought that repeated suspensions of the rules would stabilize nomenclature. It is becoming more and more evident that this is not so, and, moreover, a suspension of the rules created the problem of *Fimbria* versus *Corbis*. Because the family is not a large or important one, the writer believes that the wiser course of action is to follow the law of priority, adopt the genus name *Fimbria*, and create the new family name Fimbriidae.

SHELL MORPHOLOGY OF LIVING SPECIES OF FIMBRIA

Shell.—Porcellanous, periostracum lacking.

Valves.—Equal, not gaping, subequilateral, transversely elliptical, ventricose.

Ornamentation.—Cancellate; concentric ribs more prominent; interior ventral, anterior, and posterior margins finely crenulated; most specimens exhibiting a shallow furrow which begins at the posterior end of the umbonal area and runs obliquely posteriorly and downward, passing in front of the posterior adductor muscle scar to the ventral margin; posterior edge of this furrow marked exteriorly by a change in the character of the ornamentation; small, slightly depressed, lanceolate lunule, varying in elongation, always present; narrow, depressed escutcheon occupied by ligament except for small part of posterior portion.

Beaks.—Prosogyrate, contiguous.

Ligament.—Parivincular, opisthodetic, external but sunken.

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received October 14, 1949.

Dentition.—Lucinoid, $\frac{\text{AI, 3a, 3b, PI}}{\text{AII, 2a, 4b, PII}}$ the posterior lateral in each valve located posterior to the escutcheon and far from the other teeth.

Muscle scars.—Pallial line integripalliate, but with a small sinus where it joins the posterior adductor scar; anterior adductor muscle scar usually larger than posterior adductor muscle scar, the latter almost round; anterior adductor muscle scar produced anterodorsally; pedal retractor scars small and lying close to the adductor muscle scars at the dorsal margin.

Fimbria fimbriata (Linné)

Figs. 1, 2, 4, 6, 7

1758. *Venus fimbriata* Linné, Syst. Nat., ed. 10: 687.
1780. *Venus fimbriata* Linné. Born, Test. Mus. Caes. Vind., etc.: 69, pl. 5, fig. 4.
1784. *Venus fimbriata* Linné. Chemnitz, Neues Syst. Conch.-Cab. **7**: 3, fig. 8; 5, 52–54; pl. 43, figs. 448, 449.
1797. *Lucina* [*fimbriata*] (Linné). Bruguière, Tab. Encycl. Meth., livr. 2, vers test. biv.: pl. 286, figs. 3a–c.
1798. *Gafrarium fimbriatum* (Linné). Röding, Mus. Bolt., pt. 2: 176, no. 243.
1811. *Fimbria magna* Megerle von Mühlfeld, Entwurf Syst. Schal., Mag. Ges. Nat. freunde Berlin **5** (no. 1, art. 2): 52.
1817. *Corbis fimbriata* (Linné). Cuvier, Règ. Anim. **2**: 481.
1817. *Idothea perforata* Schumacher, Essai Nouveau Syst. hab. vers test.: 161, pl. 18, figs. 3a, b.
1822. *Corbis fimbriata* (Linné). G. B. Sowerby, Genera Recent and fossil shells, pt. 2 (12): pl. 11.
1825. *Lucina fimbriata* (Linné). Blainville, Man. malac., etc.: 551, pl. 72, fig. 4.
1842. *Corbis fimbriata* (Linné). Reeve, Conch. Syst. **1**: 81, pl. 57.
1843. *Corbis fimbriata* (Linné). Chenu, Illus. Conch., etc. **2**: genus *Corbis*, pl. 1, figs. 1, 1a–g (1845).
1858. *Gafrarium fimbriatum* (Linné). H. & A. Adams, Genera Recent Moll., etc. **2**: 470; **3**: pl. 114, figs. 3, 3a.
1862. *Corbis fimbriata* (Linné). Chenu, Man. Conch. Pal. Conch. **2**: 121, 122, fig. 584.
1869. *Fimbria fimbriata* (Linné). Pfeiffer, Conch.-Cab. **11** (Abt. 1, Veneracea): 278, 279, pl. 21, figs. 1, 2.
1873. *Corbis fimbriata* (Linné). G. B. Sowerby, *in* Reeve, Conch. Icon. **18**: *Corbis*, sp. 1 (Nov. 1872).
1921. *Corbis fimbriata* (Linné). Lamy, Journ. de Conch. **65** (3): 286–288.
1941. *Corbis fimbriata* (Linné). Hatai, Bull. Trop. Ind. Inst. Palau South Sea Islands, Japan, no. 7a, b: 68, 69, pl. 36, figs. 1, 3, 6.

Description.—The ribs vary in strength and number on *Fimbria fimbriata*, but they are generally coarser on this species than on *Fimbria soverbii.* Some of the concentric ribs are sinuous, and a few occur only on the central part of the shell. The radial ribs are more prominent on the umbonal area and at the anterior and posterior ends giving the ribs on these areas a tuberculate appearance. Radial riblets occur between the heavy concentric ribs. On well-preserved specimens faint pink or salmon coloring occurs along the margins of the shell. Large specimens show a great thickening of the shell along the ventral border with the outer layer overhanging the inner ones.

Measurements, in millimeters, are as follows:

U.S.N.M. no.	*Height*	*Length*	*Convexity (both valves)*	
599538	73.4	95.6	59.4	(Largest specimen in collection)
532314	59.7	74.5	44.0	
594281	54.0	69.7	47.3	
582737	55.0	69.3	45.4	(Largest specimen collected at Bikini)
599541	39.5	56.8	30.7	
532314	31.3	43.4	23.8	
7287	21.9	33.3	14.9	

There is some variation in the ratio of height to length and height to convexity. The immature specimens are generally longer in respect to height and convexity than mature specimens.

Remarks.—The U. S. National Museum collection contains 69 specimens of *Fimbria fimbriata;* 32 of them were collected at Bikini and other northern Marshall Islands. Localities represented by specimens in the U. S. National Museum collection are:

Caroline Islands: Lukunor Atoll, Oneap Island.

Fiji: Lau Group, Komo Island; Viti Levu Island, between Ellington and Korokula, Suva.

Hawaiian Group: Laysan Island.

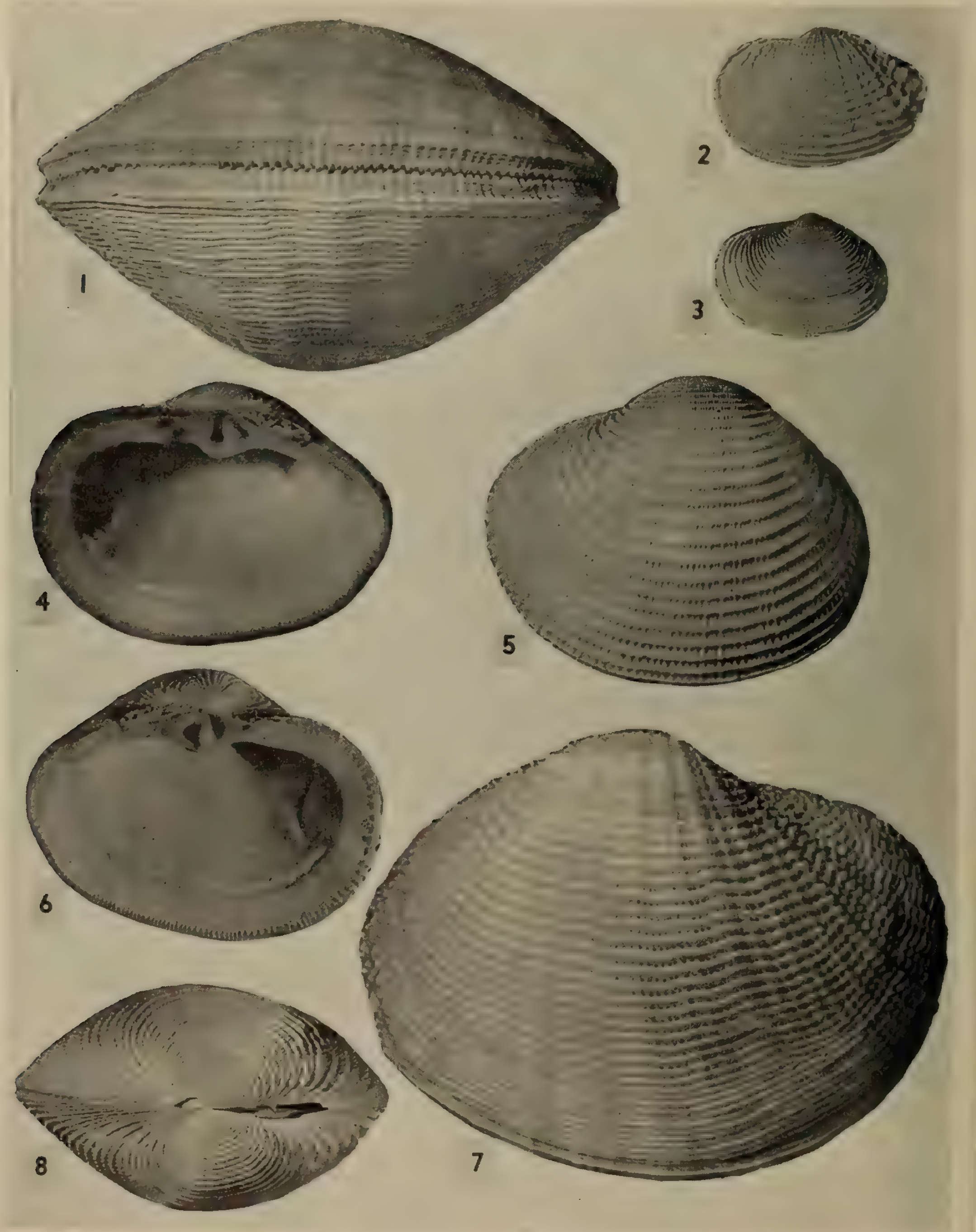
Java: Soemoer, Bantam.

Marianas: Maug Islands.

Marshall Islands: Bikini Atoll, Bikini Island, Bokororyuru Island, Ourukaen Island, Yomyaran Island; Eniwetok Atoll, East Rigili Island, Pujiyoru Island; Kwajelein Atoll; Rongelap Atoll, Arbar Island, Busch Island, Enybarbar Island, Lomuilal Island, Rongelap Island.

Palau Islands: Kayangel Islands.

Philippine Islands: Baluk Island; Basilan Island; Cebú Island, Cebú; Mani Island; Mindanao, Santa María, Zamboanga; Mindoro, Calapán; Santa Cruz Island; Tawi Tawi Group, Dammai Island, Papahag Island, Simaluc Island, Tawi Tawi Island, Tatán.



Figs. 1, 2, 4, 6, 7.—*Fimbria fimbriata:* 1, Ventral view showing thickening of valves on gerontic specimen, U.S.N.M. no. 599538; 2, Left valve exterior, juvenile, U.S.N.M. no. 7287; 4, right valve interior, U.S.N.M. no. 583009; 6, left valve interior, U.S.N.M. no. 583009; 7, right valve exterior U.S.N.M. no. 599538.

Figs. 3, 5, 8.—*Fimbria soverbii:* 3, Left valve exterior, juvenile, U.S.N.M. no. 344756; 5, left valve exterior, U.S.N.M. no. 599539; 8, dorsal view showing lunule and escutcheon, U.S.N.M. no. 599539.

(All specimens figured in the U. S. National Museum collection, Division of Mollusks. All figures $\times\frac{17}{15}$.

Fimbria soverbii (Reeve)

Figs. 3, 5, 8

1842. *Corbis soverbii* Reeve, Proc. Zool. Soc. London 1842 (pt. 9) (Proc. for Oct. 26, 1841): 85, 86.
1842. *Coris soverbii* Reeve. Reeve, Conch. Syst., etc.: **1**: 81, pl. 58.
1843. *Corbis elegans* Deshayes, Règ. Anim., etc., disciples ed., **5**: Les Mollusques, atlas, pt. 2, pl. 102, figs. 1, 1a (explanation facing pl. 102).
1843. *Corbis elegans* Deshayes. Chenu, Illus. Conch., etc., **2**: genus *Corbis*, pl. 1, figs. 2, 2a–e (1845).
1843. *Corbis sowerbii* Reeve. Hanley, Cat. Recent biv. shells: 75.
1844. *Corbis soverbii* Reeve. Hanley, Cat. Recent biv. shells: pl. 14, fig. 15, p. 348 (1856).
1850. *Corbis elegans* Deshayes. Deshayes, Traité élém. conch., etc.; 1 (pt. 2): 803, 804, pl. 15, figs. 7–9.
1858. *Gafrarium elegans* (Deshayes). H. & A. Adams, Genera Recent Moll., etc., **2**: 170.
1858. *Gafrarium sowerbii* (Reeve). H. & A. Adams, Genera Recent Moll., etc., **2**: 170.
1873. *Corbis sowerbyi* Reeve. G. B. Sowerby *in* Reeve, Conch. Icon. **18**: *Corbis*, sp. 2, pl. 1, figs. 2a, b (Nov. 1872).
1921. *Corbis elegans* Deshayes. Lamy, Journ. de Conch. **65** (3): 288.
1936. *Corbis elegans* Deshayes. Hirase, A coll. Japanese shells, etc., Tokyo, ed. 5: 15, pl. 27, fig. 6.
1941. *Corbis sowerbyi* Reeve. Hatai, Bull. Trop. Ind. Inst. Palau South Sea Islands, Japan, no. 7a, b: 68, pl. 53, fig. 2, pl. 54.

Description.—Thin concentric ribs run the length of the shell, and in large specimens they become more closely spaced ventrally. The concentric ribs are less pronounced at the anterior and posterior ends. Radial riblets appear in the interspaces and become more prominent at either end of the shell, especially on the anterior end. There are faint radial rays of orange and pink and occasionally a concentric ray of the same colors. The lunule is smaller and shorter in this species than in *Fimbria fimbriata.*

Remarks.—The U. S. National Museum collection contains only three specimens of this species; none were found at Bikini.

Measurements, in millimeters, are:

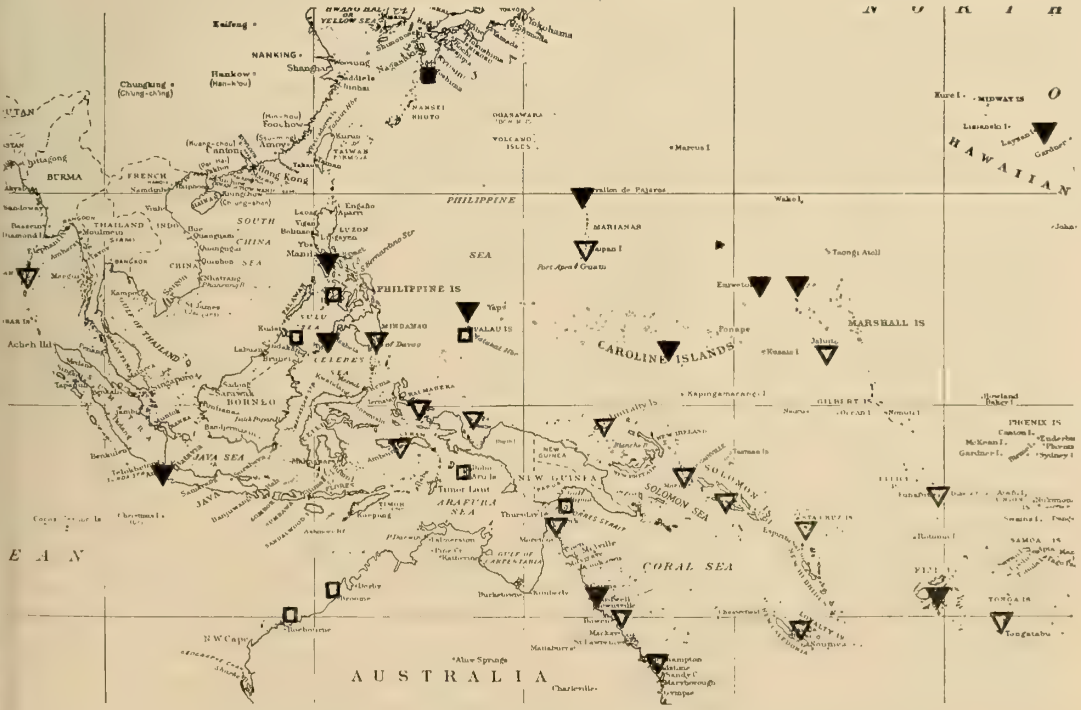


Fig. 9.—Map showing distribution of Recent species of *Fimbria:*

F. fimbriata ▲ Locality data based on U. S. National Museum specimens.
△ Locality data based on specimens in other museums and on published records.

F. soverbii ■ Locality data based on U. S. National Museum specimens.
□ Locality data based on specimens in other museums and on published records.

U.S.N.M. no.	*Height*	*Length*	*Convexity (both valves)*
599539	47.2	61.0	36.3
344756	37.3	52.7	26.8
344756	19.0	27.5	12.4

Locality represented by specimens in the U. S. National Museum collection—Japan, Kyushu, Osima Osumi.

DOUBTFUL SPECIES

Gafrarium (*Corbis*) *caelatum* A. Adams, Proc. Zool. Soc. London 1853, (pt. 21): 69, 1853 (habitat—Sorsogon, Island of Luzón, 6 fathoms, coarse sand).

Gafrarium (*Corbis*) *scitulum* A. Adams, Proc. Zool. Soc. London 1853 (pt. 21): 70. 1853 (habitat—Puerto Gallaro, 10 fathoms, coarse sand).

Dr. L. R. Cox, of the British Museum (Natural History), was unable to find the types of these two species. The original descriptions in Latin are brief, with no measurements, figures, or diagnostic characters of the genus. The writer has been unable to locate any additional data on the species in question except for their record in faunal lists of the Philippines. As Cox pointed out, a pallial sinus is mentioned in the description of *Gafrarium* (*Corbis*) *scitulum*. This would exclude the species from the Fimbriidae. These species must be considered as doubtful until more information is obtained concerning them.

SPECIES PREVIOUSLY ASSIGNED TO, BUT NOT BELONGING TO, THE FIMBRIIDAE

Chione despecta Hedley, Proc. Linnean Soc. New South Wales **29**: 193, 194, pl. 10, figs. 35–38. 1904 (genotype of *Bathycorbis* Iredale, 1930, original designation).

Corbis percostata Hedley, II. Report on the Mollusca obtained by the F. I. S. *Endeavour*, chiefly off Cape Wiles, South Australia (pt. 1): 92, 99, 100, pl. 17, figs. 9–12. 1911.

These minute Australian species have been allocated to *Corbis* by Hedley but have more recently been placed in the separate genus *Bathycorbis*. The lack of radial ribs and the presence of an elongate chondrophore are but two of the morphologic characters which would exclude these species from the Fimbriidae. Cotton and Godfrey (1938, p. 208) have placed *Bathycorbis* in the Lucinidae.

KEY TO THE RECENT SPECIES OF FIMBRIA

1. Concentric ribs coarse, some sinuous and appearing only on central part of shell *fimbriata*
2. Concentric ribs fine, running length of shell *soverbii*

ECOLOGIC AND GEOGRAPHIC DISTRIBUTION OF RECENT SPECIES OF FIMBRIA

In a letter to the writer, Dr. Joyce Allan made the following statement concerning the Australian species of *Fimbria:* "The main point about the Australian distribution is that the genus is reef-dwelling, not mainland littoral, and prefers a sandy environment." These same observations on ecology were made by Morrison at Bikini. He collected many shells at depths of not more than 25 feet on sandy coral and *Halimeda* bottoms. The geographic distribution of *Fimbria* shows its close relationship to a coral reef habitat, and although the depth to which these animals will live is not known, it is likely that they do not live at greater depths than the corals (about 200 feet).

The geographic distribution of *Fimbria* is shown on the accompanying map. These data were collected from specimens in the U. S. National Museum, from reports of other museum collections, and from the literature. *Fimbria* is such a distinctive shell that reports of its occurrence in Indo-Pacific faunas should be reasonably trustworthy. The greatest danger is incorrect locality data. The writer realizes, also, that molluscan faunal studies, particularly in the central and eastern Pacific, are not abundant enough to make the distributional picture of *Fimbria* complete. The limits of the genus eastward perhaps will expand with more collecting in that area. West of the Andaman Islands more careful collecting has been done, and more faunal lists are available. The reef conditions favorable for the genus are plentiful, but the writer was unable to find a record of it in the central and western part of the Indian Ocean. The occurrence of *Fimbria* at Laysan Island should be reaffirmed because Dall, Bartsch, and Rehder did not record it in their comprehensive work on the Hawaiian Pelecypoda.

It is noteworthy that the common species *Fimbria fimbriata* (Linné) has a broad east-west range which overlaps the much rarer *Fimbria soverbii* (Reeve). Approximately the eastern half of the distribution of *Fimbria* consists of *F. fimbriata*. *Fimbria soverbii*, on the other hand, has a north-south trending range, and it appears to be the only species in southern Japanese waters. Dr. Joyce Allan gave the writer the following data on the distribution of *Fimbria* in Australian waters:

The Australian range of *Fimbria* is from Queensland around to Northwest Australia, possibly as far south as Broome. The genus is confined to tropical rather than temperate Australian waters. It has not yet been recorded from New South Wales or southern Australia. The eastern Australian species is *F. fimbriata* which extends throughout most of the length of the Great Barrier Reef but possibly ranges into Northern Territorial waters. The western Australian species is *F. soverbii* which is found as far south as Broome.

According to Iredale's map of Australian marine provinces (1939, p. 220), all the Solanderian and at least a part of the Dampierian would encompass the Australian distribution of *Fimbria.*

From the above account it is apparent that reasonably detailed and accurate information, except for Australian waters, is lacking. In order to understand the origin and distribution of marine faunas, it is necessary to do much more thorough and careful collecting than has been done in the past.

ACKNOWLEDGMENTS

The information given by Dr. Joyce Allan (Australian Museum, Sydney) on the distribution of *Fimbria* in Australian waters has been most helpful. Dr. L. R. Cox, of the British Museum (Natural History), searched for the types of some of A. Adams's species. Additional data on the distribution of *Fimbria* were supplied by Dr. A. Myra Keen, of Stanford University, Dr. Leo G. Hertlein, of the California Academy of Sciences, and William J. Clench, of the Museum of Comparative Zoology. Dr. J. P. E. Morrison, of the U. S. National Museum, lent his notes on descriptions of localities at Bikini. The writer is greatly indebted to these persons for giving so much essential data for this paper.

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ZOOLOGY.—*A preliminary list of the cleidogonid millipeds, with descriptions of a new genus from Guatemala and a new species from Virginia.*[1] Richard L. Hoffman (Communicated by E. A. Chapin.)

While recently sorting and rearranging material in the diplopod collection of the U. S. National Museum, I discovered a vial of specimens taken in western Guatemala and labeled "*Cleidogona* n. sp." by Dr. O. F. Cook. Examination of these millipeds revealed characters that preclude their reference to *Cleidogona* or any other presently known group of the Cleidogonidae. A new genus is herewith proposed for the species, and the opportunity is taken for the inclusion of information on the cleidogonid genera recognized by me, preliminary to a projected revision of the family.

The family Cleidogonidae has, despite admirable descriptions of its members by Cook and Collins (1895), received much faulty treatment at the hands of European workers. Attems (1926) included *Cleidogona* and *Pseudotremia* in the family Pseudocleididae, a much later named based on his genus *Pseudoclis* from the Palearctic region; in this he has been followed by R. V. Chamberlin in several recent papers. The name

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[1] Received November 1, 1949.

Cleidogonidae has three years priority, and Pseudocleididae will of course fall as a synonym if only one family is involved. However, for the present I prefer to regard Pseudocleididae as a valid family for the 28-segmented European forms. The Cleidogonidae is regarded as an essentially Nearctic group.

A number of Mexican species are known, again providing a reflection of the numerous faunal affinities of the Mexican Plateau with the Appalachian region of eastern United States. The relationships of these forms are clearly with the cleidogonids of eastern North America; despite this, however, Verhoeff (1926) proposed a new family for the reception of one of them.

It is felt that a brief summary of the characters of the family as currently restricted, a key to the genera, and list of known species, may be useful to other workers, pending completion of the more detailed account.

Family CLEIDOGONIDAE

Cleidogonidae Cook, Brandtia, 1896: 8 (*Cleidogona*, *Bactropus*, *Pseudotremia*). May 18.

Pseudocleididae Attems, *in* Kükenthal and Krumbach, Handbuch der Zoologie **4**: 170. 1926 (in part—*Cleidogona* and *Pseudotremia* placed in Pseudocleididae Attems, 1899).

Mexiceumidae Verhoeff, Zool. Anz. **68**: 110. 1926.

Chordeumoidea with the following characteristics:

Adults with 30 segments, body moderately elongate, usually robust, cylindrical, subfusiform.

Head larger and wider than first segment, latter fitting into a concavity on the back of the head.

Eyes well developed as a rule, ocelli usually numerous, arranged in definite triangular or subtriangular patches.

Antennae remote at base, long and very slender, third joint much the longest, eighth with four olfactory cones.

Gnathochilarium with stipes separate, cardo small; mentum entire, trapeziform, large; promentum evident, triangular, between the bases of the lingual lamellae; latter long, distinct.

Segments nearly cylindrical, never laterally carinate but with low shoulders in *Pseudotremia*, also smooth except in that genus. Dorsum with six bristles on each segment. Repugnatorial pores absent.

Ninth legs of males reduced, the basal joints usually enlarged; usually 5-jointed with a small terminal claw. Male legs anterior of gonopods not modified.

Male gonopods large, heavily chitinized, composed as a rule of two pairs of upright pieces, the caudal pair usually the smaller and attached to the base of the cephalic. Female gonopods in the form of two subrectangular elements placed in a sclerotized receptacular portion between the second and third pairs of legs.

ARTIFICIAL KEY TO THE GENERA OF CLEIDOGONIDAE

1. Ninth male legs embracing a bifid plate, dorsum granular, gonopods lacking posterior elements, and anterior pair divided into 2 subequal parts.......... *Pseudotremia* Cope
   Ninth male legs not embracing a bifid plate, dorsum smooth, gonopods with prominent posterior elements, anterior pair not divided as above.............................. 2
2. Ninth male legs similar to others, e. g., basal joints not especially enlarged, distal not reduced.................................. 3
   Ninth male legs dissimilar to others, basal joints enlarged and distal ones reduced.... 4
3. Ocelli unpigmented and reduced in number to 14, ninth male legs 6-jointed *Cavota* Chamberlin
   Ocelli pigmented and not reduced (more than 20), ninth male legs 5-jointed *Tiganogona* Chamberlin
4. Gonopods with long tubular processes at distal end, including a definite solenomerite; ninth male legs with third joint (first tarsal) much longer than last two; no terminal claw *Solaenogona*, n. gen.
   Gonopods not as above; ninth male legs with third joint always very small and short; a terminal claw present.................... 5
5. First joint of ninth male leg with a large chitinous process extending ventrad between anterior gonopods; ninth leg 4-jointed *Rhabdarona* Chamberlin and Mulaik
   First joint of ninth male leg without process as described above; leg 2-, 3-, or 5-jointed... 6
6. Ninth male leg 2-jointed..*Mexiceuma* Verhoeff
   Ninth male leg 3- or 5-jointed............... 7
7. Ninth male legs 3-jointed; ocelli 4–7, unpigmented....................*Dearolfia* Loomis
   Ninth male legs 5-jointed; ocelli more than 20, pigmented......*Cleidogona* Cook and Collins

Genus **Cleidogona** Cook and Collins

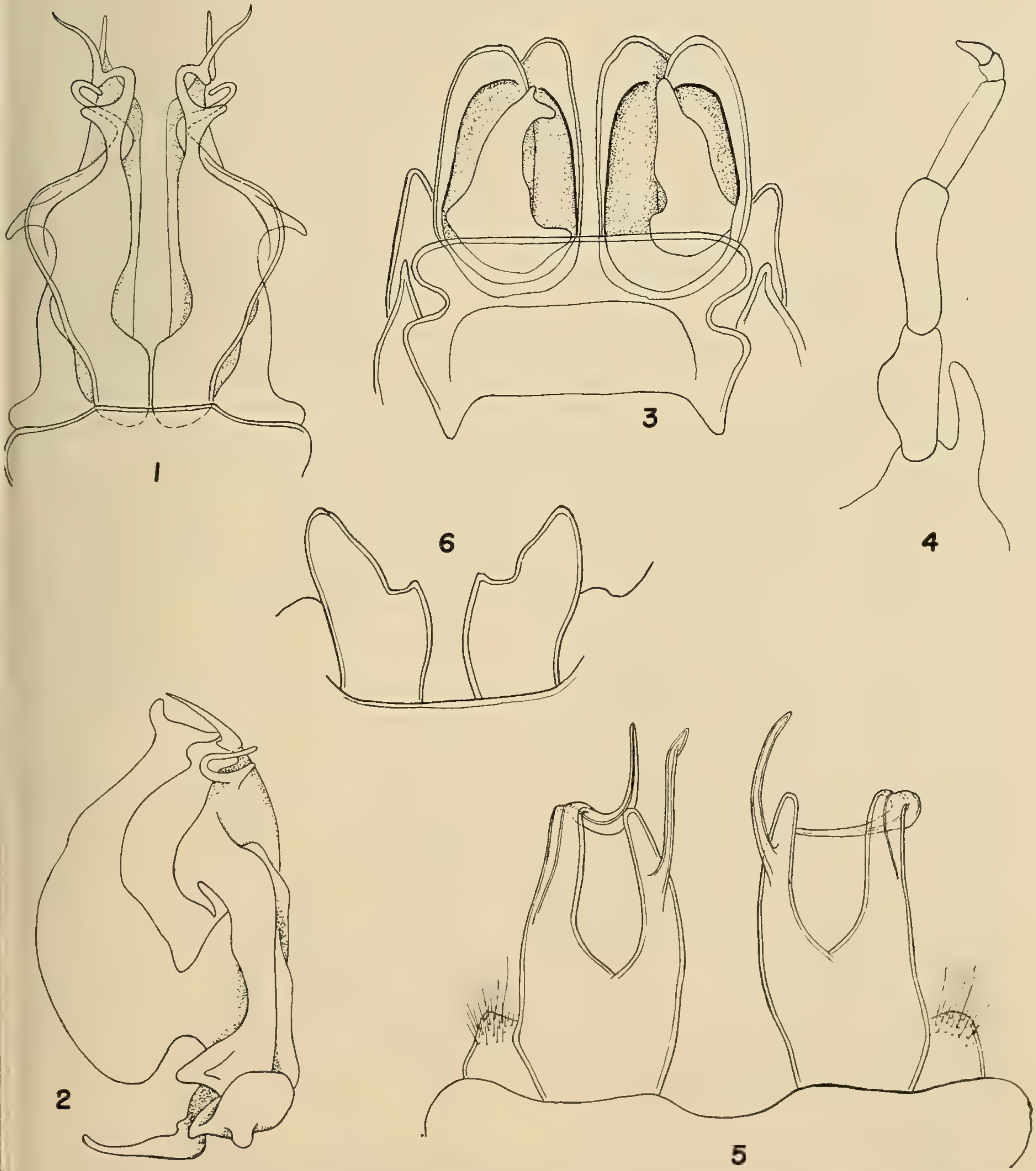
Cleidogona Cook and Collins, Ann. New York Acad. Sci. **9**: 41. 1895 (generotype, *C. major*, by original designation, p. 48).

Range.—Eastern United States from Pennsylvania and Maryland south and west to Florida, Mexico, and Guatemala.

Species.—*C. atoyaca* Chamberlin, *caesioannulata* (Wood), *ceibana* Chamberlin, *celerita* Williams and Hefner, *exaspera* Williams and Hefner, *forceps* Cook and Collins, *laminata* Cook and Collins, *major* Cook and Collins, *mexicana* (Humbert and Saussure), *mississippiana* Chamberlin, *godmani* Pocock, *nueva nueva* Chamberlin, *nueva michoacana* Chamberlin, *rafaela* Chamberlin, *stolli* Pocock, *zempoala* Chamberlin.

Genus **Cavota** Chamberlin

Cavota Chamberlin, Bull. Univ. Utah 33 (4): 8. 1942 (generotype, *C. crucis*, by original designation).



Figs. 1–6.—1, Cephalic view of male gonopods of *Solaenogona guatemalana*, n. sp., from topoparatype; 2, lateral view of same; 3, caudal view of female genitalia of *S. guatemalana*, slightly larger scale than Figs. 1 and 2; 4, ninth male leg of *S. guatemalana*, cephalic aspect; 5, cephalic view of male gonopods of *Pseudotremia hobbsi*, n. sp., from topoparatype; 6, bifid laminae of *P. hobbsi*, caudal view.

Range.—Veracruz.

Species.—*C. crucis* Chamberlin.

Genus **Dearolfia** Loomis

Dearolfia Loomis, Bull. Mus. Comp. Zool. **86** (4): 177. 1939 (generotype, *D. lusciosa*, by original designation).

Range.—West Virginia.

Species.—*D. lusciosa* Loomis.

Genus **Mexiceuma** Verhoeff

Mexiceuma Verhoeff, Zool. Anz. **68**: 112. 1926 (generotype, *M. maculata*, by original designation).

Range.—Distrito Federal, Mexico.

Species.—*M. maculata* Verhoeff.

Genus **Pseudotremia** Cope

Pseudotremia Cope, Proc. Amer. Philos. Soc. **11**: 179. 1869 (generotype, *P. cavernarum*, by original designation).

Range.—Appalachian Mountains from Georgia north to West Virginia, west in the Central Lowlands to Indiana.

Species.—*P. carterensis* Packard, *cavernarum* Cope, *eburnea* Loomis, *fulgida* Loomis, *hobbsi* n. sp., *nodosa* Loomis, *princeps* Loomis, *simulans* Loomis, *sodalis* Loomis, *sublevis* Loomis, *tuberculata* Loomis, *valga* Loomis.

Pseudotremia hobbsi, n. sp.

Figs. 5, 6

Type specimens.—Holotype, allotype, and two male paratypes, U.S.N.M. no. 1783; collected in Chestnut Ridge Cave, 2 miles north of Clifton Forge, Allegheny County, Va.; March 31, 1947, by Richard L. Hoffman. Numerous paratypes of both sexes in my personal collection.

Diagnosis.—Maximum size, 31 mm; body completely pigmented; eyes well developed, of about 19 ocelli; tergites moderately tuberculate. Male gonopods characteristic in the presence of a slender upright styliform process on the cephalic surface of the mesial division.

Description.—Body fusiform, widest at the sixth and seventh segments of the male, tapering abruptly cephalad; head conspicuously wider than the first thoracic segment; segments becoming narrower posterior to the seventh, the last three noticeably shorter and narrower. Segments only moderately tuberculate dorsally, the most pronounced sculpture affecting the metatergites of the posterior half of the body. Lateral striae small, about 18 on the side of the seventh segment, only one or two on the last three segments. Largest specimen, a male, 31 mm long.

Eyes well developed, roughly triangular in shape. Ocelli about 19, a maximum of 6 in the longest row, with the number in other rows variable. Ocelli pigmented.

Antennae long (5 mm) and slender; rather hirsute, particularly distally. In order of decrease in length, the articles arranged as follows: 3, 5, 4, 2, 6, 1, 7. Distal portion of each article except the last expanded.

Collum semicircular, slightly concave along posterior margin, elevated laterally into a small keel. Surface smooth, without a median ridge. Posterior margin with two small tubercules on each side of median line.

Last three segments smooth, slightly tuberculate in one specimen; metatergites of penultimate and antepenultimate segments bearing six setae. Anal segment truncate distally, bearing two lateral and six terminal hairs; two of the latter arise from papillae. Anal segment slightly longer than broad in dorsal aspect, subequal in length to the two preceding segments combined; slightly emarginate laterally.

Male gonopods with two major divisions as typical in the genus. The outer or lateral division is a long slender process, directed caudad and then mesiad. The inner or mesial division is much shorter and nearly straight; from its anterodistal surface projects a slender, falcate styliform branch as shown in the figure. This branch is directed proximad and exceeds the mesial division in length. In one specimen this terminal element was distally bifid.

The posterior gonopods, or bifid laminae, are relatively large and completely separated, with large mesial shoulders.

Ninth leg of male 4-jointed, basal joint shorter than the combined length of distal two. Proximal end of second joint abruptly contracted. Third joint trapezoidal and half the length of the terminal one; latter conical and noticeably constricted at midlength, provided with a sharp curved terminal claw. Legs sparingly hirsute.

Color dark brown dorsally, fading on the sides; venter and basal two-thirds of legs white, distal third of legs brown. Antennae grayish brown. Each metatergite with two large cephalolateral oblong light brown spots, margined mesially and caudally by the darker brown of the dorsum.

Range.—Headwaters of the James River in central western Virginia, known at present from

11 localities in Alleghany and Bath Counties. The relationships of this species with *P. simulans* Loomis, from the upper Potomac drainage in Pendleton County, W. Va., are worthy of investigation. Further collections in the 60-mile hiatus between the ranges of the two should be of considerable interest, in possibly revealing intergradation.

The present species is the first milliped I recognized as undescribed, and partly for this reason I take considerable pleasure in naming it for Dr. Horton H. Hobbs, Jr., except for whom my early interest in millipeds could never have become productive.

Genus **Rhabdarona** Chamberlin and Mulaik

Rhabdarona Chamberlin and Mulaik, Journ. New York Ent. Soc. **49**: 60. 1941 (generotype, *R. bacillipus*, by original designation).

Range.—Texas.

Species.—*R. bacillipus* Chamberlin and Mulaik.

Solaenogona, n. gen.

Generotype.—*Solaenogona guatemalana*, new species.

A genus of the Cleidogonidae externally resembling *Cleidogona* but distinguished by the secondary sexual modifications of both the male and female.

Male gonopods prominent, large, resembling those of *Cleidogona* but the anterior pair with long slender processes distally, one of these modified as a solenomerite. Posterior gonopods very large, distally bifid and finely setose.

Ninth legs of male 5-jointed, characteristic in the great length of the first tarsal joint (as long as tibia) and absence of terminal claw. Sternite of ninth legs produced laterally into a long slender lobe.

Female gonopods enclosed in a nearly rectangular basal part, the distal elements (valves) with their included groove facing caudad and protected by an irregularly shaped shield not found in other genera. Upper surfaces of valves not spinose or denticulate as in *Cleidogona*.

Solaenogona guatemalana, n. sp.

Figs. 1–4

Type specimens.—Male holotype, female allotype, and 10 topoparatypes of both sexes, U.S.N.M. no. 1883; collected between Santa Cruz Quiche and Totonicapam, Guatemala, May 16, 1906, by Dr. O. F. Cook.

Diagnosis.—With the characters of the genus, specifically characterized by the configuration of the genitalia.

Description.—Length of holotype, 22, width, 2.1 mm; length of allotype, 21, width, 2.0 mm.

Body like that of *Cleidogona*, subfusiform, circular, completely smooth.

Ocelli in a triangular patch, in 7 rows; counting from the anterior corner downwards arranged as follows: 1, 2, 3, 4, 5, 6, 7 = 28.

Antennae long and slender, the articles arranged in descending order of length as follows: 3, 5, 4, 2, 7, 6, 1. Third article twice as long as 4th or 2nd, half again as long as fifth. Sixth article somewhat clavate.

Male gonopods composed of two pairs of elements as in *Cleidogona*. The anterior members are upright, broad, and somewhat flattened, each becoming differentiated distally into two subdivisions both of which terminate in long slender wavy processes; the extremity of the caudal subdivision modified as a solenomerite. Seen in cephalic aspect, the gonopods clearly show the secondary division of the anterior pair (Fig. 1). The posterior gonopods, articulated to the posterior portion of the anterior, are very large, subpyriform plates, tapering distad and becoming terminally bifid.

Ninth male leg 5-jointed, the basal joint (coxofemur) short, slightly lobed at midlength; tibial joint longer, gradually expanded distally and somewhat bowed. First tarsal joint long, nearly length of tibia, and nearly twice as long as distal two tarsi. Latter very small, without terminal claw. Sternite laterad of insertion of leg produced into a long slender lobe (Fig. 4).

Female gonopods inclosed between the 2nd and 3rd pairs of legs, the sternites of which are produced caudad and cephalad respectively to provide housing and protection. The basal receptacular portion is composed of a broad sublyriform plate facing the 3rd leg pair, and lateral prolongations of it extending cephalad. Structure of valves complicated, giving the impression of two hollow containers opened on one side to reveal a duplicate structure inside, as illustrated (probably study of serial sections will be necessary for a correct interpretation of this structure). The rather large apertures are partially covered by irregular, separate, shieldlike pieces.

Color pattern as follows: prozonites dark olive-green and metazonites across back nearly black. A narrow white median line extending entire length of dorsum. On each side of the median line is a small, indistinct light dot, laterad of this is another, larger, and clearly defined white spot. Sides of metazonites brown, from the ventral side extending nearly up to the dorsolateral spot is a long, subtriangular tan mark. Legs basally white, terminal third becoming brownish. Head uniformly dark, lacking the transverse clypeal black stripe and three light areas typical of *Cleidogona*.

Remarks.—This is, to my knowledge, the southernmost known representative of the family. For both geographical and morphological reasons I am inclined to regard it as representative of the ancestral stock of *Cleidogona* and other American genera with the possible exception of *Pseudotremia*. Since only two other cleidogonids have been described from tropical America south of Mexico, it is very likely that a rich and varied fauna remains to be discovered, and that its members may throw much light on problems of relationships and evolution in the group.

Genus **Tiganogona** Chamberlin

Tiganogona Chamberlin, Ent. News **39** (5): 154. 1928 (generotype, *T. brownae*, by original designation).

Range.—Missouri.

Species.—*T. brownae* Chamberlin.

MAMMALOGY.—*A new race of badger* (Taxidea) *from Kansas.*[1] Viola S. Schantz, U. S. Fish and Wildlife Service. (Communicated by Hartley H. T. Jackson.)

Continued studies of the North American badgers reveal a new race in Kansas, where they had previously been referred to *Taxidea taxus taxus* by J. D. Black (30th Biennial Report of the Kansas State Board of Agriculture to the Legislature of the State for the years 1935 and 1936: 162, 163, 1937). I wish to express appreciation to the Kansas Museum of Natural History for the courtesy of lending me their Kansas badger specimens, which were an invaluable asset in formulating the description of this new race. The type specimen was originally in the C. Hart Merriam collection, which is now deposited in the U. S. National Museum, and I therefore name it for Doctor Merriam. It is recognized by the following description:

Taxidea taxus merriami, n. subsp.

Type.—U.S.N.M. no. 188609 (no. $\frac{3074}{3714}$ Merriam collection). Old female; skin and skull; collected at Banner, Trego County, Kansas; November 16, 1886, by A. B. Baker.

Distribution.—Kansas, approximately between longitude 97° and 101°N., except for a dip south to Hill City (22 miles east), Graham County. Carolinian biota of the Upper Austral Life Zone.

Diagnostic characters.—Individuals of this subspecies have a beige, black, and gray color mixture over the dorsal area, with the beige and black colors predominating. Specimens average smaller than *T. t. iowae* or *montana* and lack the light cinnamon-drab color of *iowae* and the sombrero of *montana*.

Color.—Type: Winter pelage. Facial area, including eyes and forehead (except median white line), and preauricular patches beaver brown; irregular white markings under and behind the eyes confluent with cream throat; white median line extends from near tip of nose over the forehead to the shoulder; general dorsal area beige (Maerz and Paul, *A dictionary of color*. 1930), black, and gray mixture, with the beige and black colors predominating. The base of the underfur and guard hair is beige; then the guard hairs have a subapical band of black tipped with gray. The longer guard hairs on the sides of the body have a basal coloring of ivory, then a narrow band of buff, followed by a subapical band of black and tipped with a wider band of gray than on the dorsal area; chin and spot at base of median tuft of gular vibrissae brownish, ears dark brown edged with white; fore and hind limbs dark mummy brown (Ridgway); upper side of tail cinnamon-buff colored with a subapical band of dark brown tipped with gray, under side of tail predominantly cinnamon-buff; tail terminates in a dark-brown tuft.

Skull.—Type: Averages smaller than those of its closely allied races *iowae* and *montana*.

Measurements.—Type: No skin measure-

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[1] Received November 23, 1949.

ments given on label of stuffed specimen. Condylobasal length, 113.8 mm; zygomatic breadth, 72.5; mastoidal breadth, 71.1; nasals, maxillaries, and frontals broken; palatal constriction, 13.7; palatilar length, 58.2; maxillary tooth row, 39.2; crown length pm^4, 10; crown width pm^4, 10; crown length m^1, 13; crown width m^1, 11.

The skin measurements of an adult female taken at Winona, Kansas, are: Total length, 608 mm; tail vertebrae, 101; hind foot, 100.

Cranial measurements, in millimeters, of one adult male: Condylobasal length, 122.1; zygomatic breadth, 75.1; mastoidal breadth, 73.3; interorbital breadth, 28.2; least postorbital breadth, 27.5; palatal constriction, 13.7; palatilar length, 61.5; maxillary tooth row, 41; crown length pm^4, 11.5; crown width pm^4, 10; crown length m^1, 13; crown width m^1, 11.

Average and extreme cranial measurements of five females, unless otherwise stated, are as follows: Condylobasal length, 117.2 (113.8–120.3); zygomatic breadth, 74.5 (67.1–79.3); mastoidal breadth (of 4), 72.5 (69.7–75.5); interorbital breadth (of 4), 27.1 (23.8–29.1); least postorbital breadth (of 3), 27.5 (26.3–29); palatal constriction, 14.5 (13.7–16.1); palatilar length, 60.3 (58.2–61.3); maxillary tooth row, 40.9 (39.2–42); crown length pm^4, 11 (10–11.3); crown width pm^4, 10.2 (10–10.5); crown length m^1, 13.6 (13–15); crown width m^1, 11 (10.2–11.6).

Remarks.—This Kansas badger, *T. t. merriami*, is most closely related to the *montana* race, which borders it on the west and with which it intergrades. The majority of the *merriami* specimens here examined, or 83 percent, have the short, white, median dorsal stripe terminating at the shoulder. In comparing *merriami* with *berlandieri* I find that the dorsal area of the former has a beige color mixture, while in the latter it is a light cinnamon-buff, with the majority of these specimens having a long white dorsal stripe extending beyond the shoulder; it differs from *taxus*, to which race it had been previously referred, in averaging slightly darker, in being more heavily washed with black, and also in being smaller.

Specimens examined.—Total number, 9, all from Kansas, as follows: Banner, Trego County, 2 (skins and skulls, type locality); Dighton, Lane County, 1 (skull only, Kansas Univ.); Harper County, 1 (skull only, Kansas Univ.); Meade County, 1 (skull only, Kansas Univ.); Little Salt Marsh, Stafford County, 2 (skins and skulls, Kansas Univ.); Trego County, 1 (skin only); Winona, Logan County, 1 (skin and skull, Kansas Univ.).

PROCEEDINGS OF THE ACADEMY

434th Meeting of Board of Managers

The 434th meeting of the Board of Managers, held in the Cosmos Club on January 23, 1950, was called to order at 8:05 p.m., by the President, F. H. H. Roberts, Jr. Also present were: F. B. Silsbee, H. S. Rappleye, N. R. Smith, H. A. Rehder, Alan Stone, F. G. Brickwedde, W. W. Diehl, F. M. Defandorf, W. N. Fenton, F. E. Johnston, F. D. Rossini, F. A. Weiss, C. A. Betts, R. S. Dill, A. O. Foster, Margaret Pittman, O. B. French, F. M. Setzler, and, by invitation, H. E. McComb, Herbert Friedmann, R. W. Brown, and M. A. Mason.

The President announced the following appointments as subcommittee members of the Committee on Membership, in accordance with the action of the Board taken at the 432d meeting, which called for the appointment of several subcommittees consisting of Academy members in various Government agencies who were to assist the Committee on Membership by submitting to them nominations of qualified scientists: Victor H. Cahalane, National Park Service; Robert D. Huntoon, National Bureau of Standards; W. Gardner Lynn, Catholic University; Jason R. Swallen, Smithsonian Institution; Bruce Wilson, National Bureau of Standards.

The Committee on Membership submitted the names of six individuals for resident membership. Eleven persons previously nominated were elected to membership.

The Chairman of the Committee on Encouragement of Science Talent, Martin A. Mason, reported that his committee has begun their work in collaboration with Science Service for the selection of the outstanding high-school science students in the District of Columbia. His committee has also made the annual requests for funds to defray the expenses in connection with the Science Fair. The expenses of approximately $700 will have to be defrayed by contributions from the Academy as well as the Affiliated Societies. Several of the Affiliated Societies indicated that allotments had already been approved for the Science Fair.

Neil M. Judd, having retired after 38 years of Government service on December 31, 1949, and no longer gainfully employed, was placed on the retired list.

The Secretary reported the following deaths: Charles J. Clifford, U. S. Coast and Geodetic Survey, on December 21, 1949 (elected January 14, 1946); Clarence N. Fenner, formerly of the Geophysical Laboratory, on December 24, 1949 (elected March 1, 1913); Alfred J. Lotka, formerly with the Metropolitan Life Insurance Company, on December 5, 1949 (elected December 14, 1914).

The Treasurer reported that the Auditing Committee had gone over his accounts, which have been approved.

The Custodian and Subscription Manager of Publications, H. A. Rehder, reported the sale thus far of 80 copies of the monograph and indicated that he plans to circularize universities and libraries now on our subscription list informing them that this monograph is the first of a continuing series.

Vice President Silsbee reported that the Philosophical Society of Washington cancelled its regular meeting on January 28 so that it would not interfere with the annual meeting of the Academy. The Secretary was instructed to write to the President of the Society expressing the thanks of the Academy.

The meeting adjourned at 9:05 p.m.

F. M. Setzler, *Secretary.*

New Members of the Academy

There follows a list of persons elected to resident membership in the Academy, by vote of its Board of Managers, since June 1, 1949, who have since qualified as members in accordance with the bylaws. (See also previous list in the October 15, 1949, issue of Journal.)

Elected June 13, 1949

F. R. Fosberg, research associate, Biology Department, Catholic University of America, in recognition of his contributions to botany, in particular the taxonomy of the Pacific islands' flora and of the family Rubiaceae, especially the genera *Cinchona* and *Hedyotis*; also for his active interest in the international aspects of botany, in the economic plants of the world, and in the organization of facilities for botanical research.

Hubert W. Lakin, chemist, U. S. Department of Agriculture, in recognition of his contributions to the knowledge of minor elements in soils and rocks and also to the understanding of the effects of selenium and other toxic minor elements in soils.

Arthur A. Maryott, physical chemist, National Bureau of Standards, in recognition of his contributions to physical chemistry, in particular his researches on the dipole moments of organic molecules.

T. P. Thayer, geologist, U. S. Geological Survey, in recognition of his work in economic geology of chromite and petrology of peridotite and gabbro, structural and petrologic studies in Oregon, and reconnaissance mapping in eastern Cuba and western Liberia.

Elected October 17, 1949

R. Percy Barnes, professor of chemistry, Howard University, in recognition of his contributions to organic chemistry, in particular his researches on alpha and beta diketones.

Vernon H. Dibeler, general physical scientist, National Bureau of Standards, in recognition of his contributions to physical chemistry, especially to mass spectroscopy.

Joseph R. Kanagy, chemist, National Bureau of Standards, in recognition of his studies of the composition of leather, in particular his investigations of the chemistry of collagen.

E. L. LeClerg, research coordinator, Agricultural Research Administration, in recognition of his contributions to phytopathology, particularly in the field of sugar-beet and potato diseases.

Curtis May, pathologist, Bureau of Plant Industry, Soils, and Agricultural Engineering, in recognition of his contribution to forest pathology, in particular for studies of the Dutch elm disease and other dangerous introduced tree diseases.

Emma J. McDonald, organic chemist, National Bureau of Standards, in recognition of her contributions to the chemistry of carbohydrates, in particular her studies of the structure of polyfructosans.

Carl F. Miller, archeologist, River Basin

Surveys, Smithsonian Institution, in recognition of his contributions to the archeology of the Southeastern United States.

W. Harold Smith, organic chemist, National Bureau of Standards, in recognition of his contributions to organic chemistry and his work on the crystallization of rubber.

W. W. Walton, Sr., chemist, National Bureau of Standards, in recognition of his contributions to organic and analytical chemistry.

Elected November 14, 1949

Donald H. Loughridge, senior scientific adviser, Office of the Assistant Secretary of the Army, in recognition of his contributions to physics, in particular his work on photoelectric effects and on cosmic-ray intensities.

Ralph S. Solecki, archeologist, River Basin Surveys, Smithsonian Institution, in recognition of his contribution to the knowledge of the archeology of New York State and West Virginia.

Obituaries

William Jackson Humphreys, physicist and meteorologist of international repute, died in Washington, D. C., on November 10, 1949, at the age of 87 years. He was president of the Washington Academy of Sciences in 1922.

Dr. Humphreys was born at Gap Mills, Virginia (now West Virginia), on February 3, 1862, the son of Andrew Jackson Humphreys and Eliza Ann (Eads) Humphreys. He was educated in the public schools near Gap Mills, at a high school in Pomeroy, Ohio, and at Washington and Lee University, Lexington, Va., where he received the bachelor of arts degree in June 1886 and that of civil engineer two years later. He did postgraduate work at the University of Virginia and at Johns Hopkins University, receiving the Ph.D. degree at the latter place in 1897.

In 1888 Dr. Humphreys was offered a job as rodman with the U. S. Coast and Geodetic Survey but did not accept it. His first work was to teach school, in which he was engaged for five years, 1889–1894. Later, from 1897 to 1905, he was on the staff of the University of Virginia where he taught in the physics department. During two of the summers while he was at the University of Virginia he went on eclipse expeditions with the U. S. Naval Observatory, in 1900 to Georgia and in 1901 to Sumatra. In the summer of 1904 he was secretary of the section on the physics of the electron at the International Congress of Arts and Sciences at St. Louis. He was brought into the U. S. Weather Bureau in 1905 through the influence of Prof. Frank Hagar Bigelow, and he remained with the Weather Bureau until his death. He was technically retired in 1935 after 30 years of service, but he was immediately appointed a collaborator and continued to work at his desk as if there had been no change, either in his salary or his responsibility. Beginning about 1942, owing to his advanced age, he went to the office less and less regularly and by 1948 he was able to go only about three times during that year, but he was still being carried on the rolls of the Weather Bureau as a collaborator at the time of his death.

Naturally, prior to 1905, all Dr. Humphreys' writings, and they were numerous, were in the field of physics or the borderline fields of physics and astronomy or physics and chemistry. Following his employment in the U. S. Weather Bureau he wrote numerous papers on meteorology. He was perhaps the most prolific meteorological writer in America. One of his early papers and possibly his most noteworthy one on meteorology was in 1909 when he offered an explanation for the existence of the Stratosphere. His final paper, "Loose Usage of Weather Words," was published in this Journal in April 1948. He wrote a number of books. *Physics of the air* went through three editions—1920, 1928, and 1940; *Weather proverbs and paradoxes* two, 1923 and 1934; *Fogs and clouds* two, 1926 and 1943; while *Rain making and other weather vagaries*, *Weather rambles*, and *Ways of the weather* had a single edition each. Dr. Humphreys was an uncanny writer in that he seemed to have a born faculty of selecting the right word for the right place and of putting each word to its maximum use. He also published an autobiography *Of me*, collaborated with W. A. Bentley in the publication of *Snow crystals*, and wrote parts or chapters of several other books.

Dr. Humphreys' hobby was the Cosmos Club. He was elected to membership in 1905 and served as its president in 1936 and on its entertainment committee from 1929 to 1946. He took keen interest in composing the announcements of these entertainments; 95 pages of his 375-page autobiography are devoted to these announcements.

Besides being president of the Washington Academy of Sciences, and of the Cosmos Club, he was president of the American Meteorological Society in 1928–1929. He also held numerous other offices in these and other professional and scientific societies, too extensive to list here. Also from 1911–1934 he was a part-time professor of meteorological physics at the George Washington University.

On January 11, 1908, he married Margaret Gertrude Antrim, of an old and well-known Virginia family, who survives him. They had no children.

In the passing of Dr. Humphreys America loses one of its great students of meteorology. The name of William Jackson Humphreys properly belongs with those of Matthew Fontaine Maury, William Ferrel, Cleveland Abbe, and Frank Hagar Bigelow.

RICHMOND T. ZOCH.

FRANK ERNEST ALOYSIUS THONE, biologist and science writer, for 25 years a member of the staff of Science Service, died in Washington, D. C., on August 25, 1949, in his fifty-ninth year. Though he had not been in good health for some time, death came unexpectedly; it was due to coronary occlusion. Burial was at Des Moines, Iowa.

Thone was born in Davenport, Iowa, on April 12, 1891. He attended the public schools in Des Moines and in 1915 took his bachelor of arts degree at Grinnell College at Grinnell, Iowa. During World War I he served as a second lieutenant in the United States Army, but after the war he continued his education at the University of California, the Johns Hopkins University, and the University of Chicago, where in 1922 he received his Ph.D. degree. Following this he served as instructor in biology at North Dakota State College (1923) and as associate professor of botany at the University of Florida (1923–24). He spent two summers (1922–24) as naturalist-lecturer at Yellowstone National Park and wrote *Trees and flowers of Yellowstone National Park*, published in 1923. Illustrated with drawings by his sister, also a botanist, the book describes and figures more than a hundred plant species found in the park and is still regarded highly among works of its kind. Thone's special scientific fields of interest were plant ecology and atmometrics.

Dr. Thone joined the staff of Science Service in 1924 and thereafter made an enviable name for himself in the popularization of science. As a science writer he specialized in biological departments, but because of his broad interest in all the sciences he was able to handle assignments of widely diverse nature. In 1925 he covered the famous Scopes "monkey" trial at Dayton, Tenn., and more than 20 years later was a correspondent at the Bikini atom-bomb tests, the Operation Crossroads of the United States Navy. He wrote extensively for the Science Service syndicated releases and newsletters and was known especially for his nature columns. A regular newspaper feature that he wrote was a weekly story on new patents. In 1940 he published *The microscopic world*, a popular book on microbiology. In 1946 he was one of 13 recipients of the George Westinghouse distinguished science-writing awards. His writing was characterized by a captivating and original manner of expression but withal a high fidelity to scientific accuracy. His scientific training enabled him to understand the scientist's viewpoint, but at the same time he had a real talent for writing understandably and interestingly for the lay reader. He was an indefatigable worker, and the total product of his pen if it could be assembled would be astonishingly voluminous.

Dr. Thone took a lively part in the scientific life of Washington. Not only was he a member of many scientific organizations, but he was always cooperative in serving as an officer or upon committees, and he never assumed these duties perfunctorily. He was active in the affairs of the American Association for the Advancement of Science, the Washington Academy of Sciences (of which he had been a member for 10 years), and the National Association of Science Writers. He was a member also of the Botanical Society of America, the American Society of Plant Physiologists, the American Society of Mammalogists, the Seismological Society of America, the Wildlife Society, the National Parks Association, the Biological Society of Washington (president 1944–46), the Botanical Society of Washington, the Wild Flower Preservation Society, the Overseas Writers, the Outdoor Writers Association, the Catholic Commission on Intellectual and Cultural Affairs, the Cosmos Club of Washington, Sigma Xi, and Phi Beta Kappa.

Widely read and traveled, of genial nature, and a good conversationalist, Frank Thone left a host of friends in Washington and among scientists throughout the world. He will be sorely missed by all of them. Unmarried, he lived at 1424 Chapin Street, NW. He attended St. Matthew's Cathedral in the Capital. He is survived by his mother, Mrs. Mary Anna Thone, and a sister, Margaret A. Thone, both of Des Moines, Iowa.

PAUL H. OEHSER.

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PHYSICS.—*Note on the specific heat of liquid-vapor mixtures.*[1]

L. GOLDSTEIN, Los Alamos Scientific Laboratory of the University of California, Los Alamos, N. Mex. (Communicated by F. G. BRICKWEDDE.)

In this paper it is shown that the experimental determination of the constant volume specific heat discontinuity in crossing the vapor or liquid saturation line of a fluid provides a direct verification of one group of Ehrenfest type of thermodynamic relations.

Consider the diagram of state of an ordinary fluid in the pressure-volume plane. One can easily evaluate the specific heat at constant volume of the fluid in a state represented by a point (p, v) on the isothermal T in the region of the liquid and vapor mixture. Let us limit ourselves first to the region $T < T_c$, $p < p_c$, $v > v_c$, the subscript c referring to the values of these coordinates at the critical point. Let x be the quality of the mixture. Then, the absorption of an amount of heat dQ by the unit mass of the mixture leads to the transformation,

$$dQ = L\,dx + [c_{sl}(1 - x) + c_{sv}x]\,dT, \quad (1)$$

where L is the latent heat of vaporization at temperature T, c_{sl} and c_{sv} are the specific heats of the liquid and vapor phases along their respective branches of the saturation curve at the same temperature T. The volume of the unit mass of the mixture is defined by

$$v = u_l(1 - x) + u_v x, \quad (2)$$

u_l and u_v denoting the volumes of the unit mass of the saturated liquid and saturated vapor. With

$$c_{sl} - c_{sv} = \frac{dL}{dT} - \frac{L}{T}, \quad (3)$$

one obtains,

$$\left(\frac{dQ}{dT}\right)_v = c_v = c_{sl} - \frac{Lx}{T} + \frac{d(Lx)}{dT}, \quad (4)$$

for the constant volume specific heat of the mixture in the state (p, v, T).

The preceding expression describes the variation of this specific heat along a v = Constant line in the (p, v) plane. We have computed this specific heat for water along the

$$v = v(100° \text{ C.}), \qquad v = v(120° \text{ C.}),$$
$$\text{and } v = v(140° \text{ C.})$$

lines, respectively, in the mixture region and completed the calculation by noting the experimental values of the constant volume specific heat of the vapor in crossing the saturation line.

The results of these calculations are given in Fig. 1.

The high specific heat of the mixture is due to the evaporation taking place in the transformations along the constant volume lines. The values of the discontinuities are defined by

$$\Delta c_v = c_{v+} - c_{v-}, \quad (5)$$

c_{v+} and c_{v-} being the constant volume specific heats of the high and low temperature "phases" at the transition points. Of these, the low temperature phase is the liquid and vapor mixture, while the high temperature phase is the pure vapor phase or liquid phase, depending on whether one follows a constant volume line, in the (p, v) plane, at $v > v_c$ or $v < v_c$, respectively.

A general expression can now be derived for c_v, without difficulty. Since, according to the Clapeyron equation,

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[1] Received January 5, 1950.

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$$L = T\frac{dp}{dT}(u_v - u_1), \tag{6}$$

and, from equation (2), along a constant volume line,

$$\begin{aligned} dv &= (1-x)\,du_1 + x\,du_v + dx(u_v - u_1) \\ &= 0, \end{aligned} \tag{7}$$

one finds,

$$dx = -\frac{1}{(u_v - u_1)}[(1-x)\,du_1 + x\,du_v]. \tag{8}$$

Substituting (6) and (8) into equation (1), one obtains:

$$\begin{aligned} \left(\frac{dQ}{dT}\right)_v = c_v = (1-x)&\left[c_{sl} - T\frac{dp}{dT}\frac{du_1}{dT}\right] \\ &+ x\left[c_{sv} - T\frac{dp}{dT}\frac{du_v}{dT}\right]. \end{aligned} \tag{9}$$

At the vapor saturation curve, $x \rightarrow 1$, and

$$\begin{aligned} c_{v-} &= \lim_{x\to 1} c_v \\ &= c_{sv} - T\frac{dp}{dT}\frac{du_v}{dT}, \end{aligned} \tag{10}$$

while the constant volume specific heat of the saturated vapor, which is that of the phase beyond or in the vicinity of the saturation curve, is, according to thermodynamics,

$$c_{v+} = c_{sv} - T\left(\frac{\partial p}{\partial T}\right)_{u_v}\frac{du_v}{dT}, \tag{11}$$

where $\left(\frac{\partial p}{\partial T}\right)_{u_v}$ is to be computed from the equation of state of the saturated vapor. Hence, from (10) and (11),

$$\begin{aligned} \Delta c_v &= c_{v+} - c_{v-} \\ &= -T\left(\frac{du_v}{dT}\right)\left[\left(\frac{\partial p}{\partial T}\right)_{u_v} - \frac{dp}{dT}\right] \\ &= -T\left(\frac{du_v}{dT}\right)\Delta\left(\frac{\partial p}{\partial T}\right)_v, \end{aligned} \tag{12}$$

where, we write

$$\begin{aligned} \Delta\left(\frac{\partial p}{\partial T}\right)_v &= \left(\frac{\partial p}{\partial T}\right)_{v+} - \left(\frac{\partial p}{\partial T}\right)_{v-}, \\ &= \left(\frac{\partial p}{\partial T}\right)_{u_v} - \frac{dp}{dT}, \end{aligned} \tag{13}$$

since in the mixed phase region,

$$\left(\frac{\partial p}{\partial T}\right)_{v-} = \frac{dp}{dT},$$

the temperature coefficient of the pressure is equal to the slope of the vapor pressure curve. Equation (12) is often called the Ehrenfest formula expressing the discontinuity of the constant volume specific heat Δc_v across a transition line.

As long as v is large in comparison with v_c, one may use, approximately, the perfect gas law for the equation of state of the saturated vapor. One has, then, approximately,

$$\begin{aligned} \Delta c_{v}{}_{\,v>v_c} &= c_{v,\mathrm{vap.}} - \lim_{x\to 1} c_{v,\mathrm{mix.}} \\ &= T\left(\frac{du_v}{dT}\right)\left[\frac{dp}{dT} - \frac{p}{T}\right]. \end{aligned} \tag{14}$$

The knowledge of the temperature variation of the vapor specific volume, i.e., $\left(\frac{du_v}{dT}\right)$ and the vapor pressure curve of the substance under consideration, allows one to evaluate the constant volume specific heat jump Δc_v.

Formula (12) leads at once to the following general conclusion concerning the sign of the discontinuity Δc_v at volumes larger than the critical volume. Along the vapor saturation curve, one has necessarily

$$\frac{du_v}{dT} < 0, \qquad u_v > v_c;$$

on the other hand,

$$\left(\frac{\partial p}{\partial T}\right)_{u_v} < \frac{dp}{dT};$$

hence,

$$\Delta c_{v}{}_{\,v>v_c} < 0, \tag{15}$$

along the vapor saturation curve. The constant volume specific heats of normal fluids undergo a lambda point type of discontinuity at the crossing of the vapor saturation curve.

We should like to consider now the transition across the liquid saturation curve, or the constant volume specific heat changes along constant volume lines $v < v_c$. One finds here

$$\begin{aligned}\underset{v<v_c}{\Delta c_v} &= c_{v+} - c_{v-} \\ &= c_{v+} - \lim_{x\to 0} c_{v,\text{mix.}}\,,\end{aligned} \tag{16}$$

where, the constant volume specific heat of the saturated liquid is

$$c_{v+} = c_{sl} - T\left(\frac{\partial p}{\partial T}\right)_{u_1}\left(\frac{du_1}{dT}\right), \tag{17}$$

the partial derivative $\left(\frac{\partial p}{\partial T}\right)_{u_1}$ being derived from the equation of state of the liquid. Also,

$$\begin{aligned}\lim_{x\to 0} c_{v,\text{mix.}} &= c_{vl} \\ &= c_{sl} - T\left(\frac{dp}{dT}\right)\left(\frac{du_1}{dT}\right).\end{aligned} \tag{18}$$

Hence,

$$\begin{aligned}\underset{v<v_c}{\Delta c_v} &= T\left(\frac{du_1}{dT}\right)\Delta\left(\frac{\partial p}{\partial T}\right)_v \\ &= T\left(\frac{du_1}{dT}\right)\left[\frac{dp}{dT} - \left(\frac{\partial p}{\partial T}\right)_{u_1}\right].\end{aligned} \tag{19}$$

Now, the temperature coefficient of the specific volume of the saturated liquid is positive,

$$\frac{du_1}{dT} > 0,$$

while the partial derivative $\left(\frac{\partial p}{\partial T}\right)_{u_1}$ of the saturated liquid is always such that

$$\left(\frac{\partial p}{\partial T}\right)_{u_1} > \frac{dp}{dT}, \qquad u_1 < v_c\,.$$

As a result,

$$\underset{v<v_c}{\Delta c_v} < 0, \tag{20}$$

or the discontinuity is again negative in crossing from the mixture region into the pure liquid phase region. However, there is a considerable difference in the numerical values of the Δc_v's at the same temperature. One finds that

$$\left|\underset{v>v_c}{\Delta c_v}(T)\right| > \left|\underset{v<v_c}{\Delta c_v}(T)\right|. \tag{21}$$

Since

$$\begin{aligned}\left(\frac{\partial p}{\partial T}\right)_{u_1} &= \frac{1}{u_1}\left(\frac{\partial u_1}{\partial T}\right)_p\left[-u_1\left(\frac{\partial p}{\partial v}\right)_T\right] \\ &= \frac{\alpha_s}{\chi_{T,s}}\end{aligned}$$

where α_s and $\chi_{T,s}$ are respectively the volume expansion coefficient and the isothermal compressibility of the saturated liquid, which quantities are likely to be well approximated by the bulk liquid values at the pressure

Table 1.—Verification of the Ehrenfest Relations (Water) across the Vapor Saturation Line[1]

(1) $$\begin{aligned}\underset{v>v_c}{\Delta} c_v &= T\left(\frac{dV}{dT}\right)^2\Delta\left(\frac{\partial p}{\partial v}\right)_T \\ &= -T\left(\frac{dV}{dT}\right)\Delta\left(\frac{\partial p}{\partial T}\right)_v\end{aligned}$$

(2) $$\underset{v>v_c}{\Delta}\left(\frac{\partial p}{\partial T}\right)_v = -\left(\frac{dV}{dT}\right)\Delta\left(\frac{\partial p}{\partial V}\right)_T$$

$T°$ C.	100	120	140	160	180
$-\Delta c_v$ cal/gm. degree	16.36	14.11	12.11	10.70	8.95
$-T\left(\frac{dV}{dT}\right)^2 \Delta\left(\frac{\partial p}{\partial V}\right)_T$ cal/gm. degree	16.64	14.06	12.76	11.26	9.57
$-\underset{v>v_c}{\Delta}\left(\frac{\partial p}{\partial T}\right)_v$ mm Hg/degree	25.13	43.31	69.64	106.8	155.9
$\left(\frac{dV}{dT}\right)\Delta\left(\frac{\partial p}{\partial V}\right)_T$ mm Hg/degree	25.24	43.97	72.08	111.1	164.0

The increasing deviations at the higher temperatures are probably due to the ideal gas approximation of the saturated vapor equation of state and the use of ordinary liquid thermal properties instead of those of the saturated liquid.

[1] Most of the data used here were taken from the Landolt-Bornstein tables and from the book by N. E. Dorsey, *Properties of ordinary water substance*, Reinhold Publishing Corporation, New York (1940).

and temperature in question, the discontinuity (18) becomes

$$\underset{v<v_c}{\Delta c_v} = T\left(\frac{du_1}{dT}\right)\left[\frac{dp}{dT} - \frac{\alpha}{\chi_T}\right]. \qquad (22)$$

Beside the specific heat discontinuities, one obtains, by expressing the absence of discontinuities of pressure across the transition line,

$$\underset{v>v_c}{\Delta}\left(\frac{\partial p}{\partial T}\right)_v = -\frac{du_v}{dT}\Delta\left(\frac{\partial p}{\partial V}\right)_T. \qquad (23)$$

Here

$$\Delta\left(\frac{\partial p}{\partial V}\right)_T = \left(\frac{\partial p}{\partial V}\right)_{\text{vap.}} - \left(\frac{\partial p}{\partial V}\right)_{\text{mix.}}$$

$$= \left(\frac{\partial p}{\partial V}\right)_{\text{vap.}},$$

since for the mixture the vapor pressure is independent of the volume. The left side of (23) is given by equation (13), so that again a full verification of equation (23) can be obtained. At temperatures T far enough from the critical temperature $\left(\frac{\partial p}{\partial V}\right)_{\text{vap}}$ may be taken to be the ideal gas value.

Equations (14) and (23) have been verified, by the writer, for water at a number of temperatures extending from 100°C. to 180°C. It appears then that the different types of discontinuities associated with the transition across the saturation lines corre-

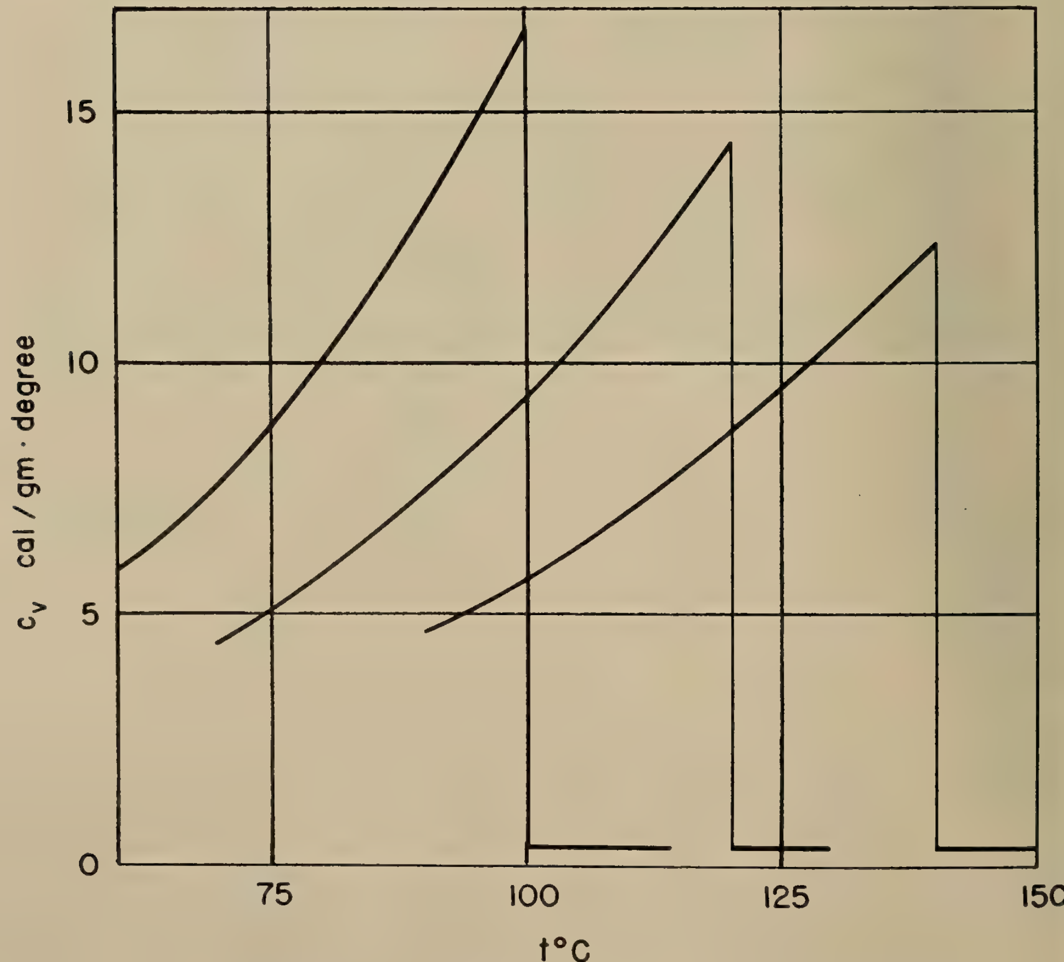

Fig. 1.—Constant volume specific heat of water vs. temperature (°C.), along constant volume lines in the liquid-vapor mixed phase and across the vapor saturation line.

spond to those expressed by Δc_v or $\Delta \left(\frac{\partial p}{\partial V}\right)_T$ and provide an interesting check of the so-called Ehrenfest type formulae.[2]

Very recently we had the opportunity of learning, through the courtesy of Dr. F. G. Brickwedde, of preliminary measurements of constant volume specific heats of liquid-vapor mixtures of oxygen, performed by Dr. H. J. Hoge at the National Bureau of Standards. These as yet unpublished data, kindly put at our disposal by Dr. Hoge, tend to confirm the expected behavior of the constant volume specific heat of liquid-vapor mixtures and are similar to those derived for water and given in Fig. 1.

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[2] The behavior of normal fluids in the liquid-vapor mixed phase region and the thermodynamic relations governing the discontinuities of the constant volume specific heat at the crossing of the saturation curve have been shortly mentioned in a previous paper, cf. L. Goldstein, Journ. Chem. Phys. **14:** 276. 1946.

ARCHEOLOGY.—*An archeological survey of the Chattahoochee River Valley in Florida.*[1] Ripley P. Bullen, Florida Board of Parks and Historic Memorials. (Communicated by Gordon R. Willey.)

Construction of the Jim Woodruff Dam on the Apalachicola River, south of the confluence of the Chattahoochee and Flint Rivers, will form a large lake covering 37,500 acres of Alabama, Florida, and Georgia. Realizing that much data pertaining to the prehistory of Florida would otherwise be lost, the Florida Park Service instigated an archeological survey of the west side of the Chattahoochee River to include the 8,500 acres of Florida to be inundated. Except for one mound excavated by Moore in 1903, this territory was archeologically unknown.

Field work was done during October and November 1948 under the general supervision of John W. Griffin, archeologist of the Florida Board of Parks and Historic Memorials. Dr. Raymond F. Bellamy, of the Florida State University, twice spent several days helping with the field work. Dr. John M. Goggin, of the University of Florida, aided in the identification of types of pottery. The survey is also indebted to Dr. A. R. Kelly, of the University of Georgia, and William H. Sears, of the University of Michigan, for an introduction to pottery types of southwest Georgia; to Dr. Frank H. H. Roberts, Jr., of the Smithsonian Institution, for the procurement of necessary maps; to Dr. Gordon R. Willey, also of the Smithsonian Institution, for manuscript sheets covering pottery descriptions from his forthcoming publication; and to Wesley R. Hurt, of the University of Michigan, for a copy of a preliminary report on his survey of the middle Chattahoochee River Valley in Alabama. O. W. Tidwell, resident engineer of the Jim Woodruff Dam project; Dr. J. H. Therrell, superintendent; Col. Charles V. Imeson, engineer; and Paul Bemis, farm manager, of the Florida State Hospital, were most cooperative. All land owners freely gave permission to work on their land.

A contour map of the area covered by the survey, showing site locations, is presented as Fig. 1.[2] The survey was limited to land below the 80-foot contour—77 feet being the elevation of water to be impounded by the Jim Woodruff Dam—and to higher land immediately adjacent thereto. For practical purposes that meant the land between a road, which runs northward from Sneads, and the Chattahoochee Fiver (Fig. 1). Many private field, wood, and logging roads extend eastward from this road toward the river. Transportation was by car as far as possible, then on foot carrying tools, maps, notes, etc.

Plowed fields and old cultivated areas were walked over and tested by means of small holes to see if Indian material was present below the plowed zone. Places where erosion had occurred were examined. In the bottomland, where no evidence of occupation could be found on the surface, innumerable holes were dug at places of

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[1] Received January 9, 1950.

[2] Reduced from topographic survey sheets kindly supplied by the U. S. Engineers Office, Mobile, Ala.

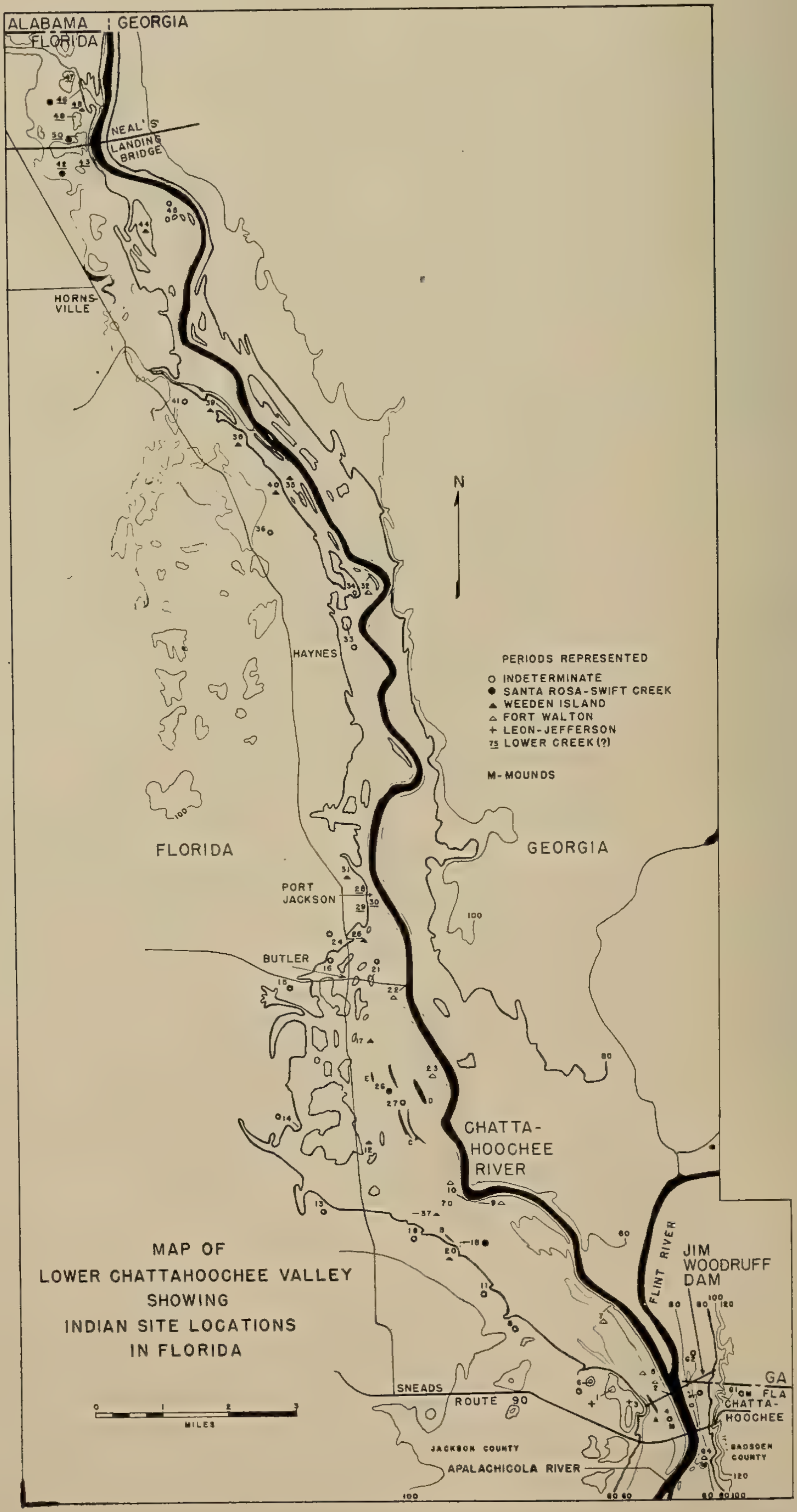

Fig. 1.—Map of Lower Chattahoochee River, showing location of Indian sites.

slightly higher elevation which might have been occupied. Along the recent natural levee these holes had to be as deep as three or four feet to uncover Indian remains. Face of the levee was frequently examined for occupational zones. At buried sites several test squares were excavated to secure an adequate sample, check stratigraphy, and record profiles.

The map (Fig. 1) indicates few sites southeast of Hayes and east of Hornesville. These areas were heavily wooded, which no doubt explains the failure to locate sites above the 80-foot contour. The present natural levee along this portion of the Chattahoochee was carefully tested with negative results except for site 32.

Fifty-four Indian sites were investigated during the survey. These are located on the map (Fig. 1), and their allocation to various archeological periods is indicated by symbols (explained on the map). Geographical factors appear to have affected the location of Indian sites in the lower Chattahoochee Valley during certain archeological periods. This is mentioned here so that the reader may, if he wishes, examine the map and anticipate certain conclusions while reading the sections on geographical background and summary of sites.

Allocation of sites to archeological periods was based on their ceramic inventory and follows the chronological scheme presented by Willey and Woodbury (1942) for the northwest Florida coast. To this ceramic sequence of Deptford, Santa Rosa-Swift Creek, Weeden Island I, Weeden Island II, and Fort Walton has been added the Leon-Jefferson Spanish mission period defined by Smith (1948) and, tentatively, for the lower Chattahoochee Valley, a later Lower Creek (?) period. Ceramic typology follows Willey's recent definitions (1945, 1948, 1949). Types for the Leon-Jefferson priod have been defined by Smith (1948), Alachua Cob Marked by Goggin (1948a), and Pinellas Incised B by Griffin (MS.). Chattahoochee Brushed is defined below.

TYPE: CHATTAHOOCHEE BRUSHED

Definition as a type: Defined here on basis of 203 sherds found in lower Chattahoochee Valley. See Figs. 10, *e*; 11, *b-d*.

Paste:

Method of manufacture: By some annular method of vessel building.

Temper: Sand and medium coarse grit rather abundant.

Texture: Coarse, lumpy, and contorted.

Hardness: 3.5

Thickness: 5–8 mm.

Color: Cores are white, light gray, or black. Surfaces are white, whitish-blue, and light gray, sometimes tan.

Surface finish and decoration: Interiors are well smoothed. Some smoothing of exteriors before brushing. Temper particles protrude on both surfaces. Exteriors brushed or scored, producing fine lines which vary from 0.2 to 1 mm in width. While irregularly applied, lines tend to parallel each other. Brushing may be limited to upper part of vessels as plain sherds, otherwise the same, were found.

Filming: Vessels probably received a clay wash.

Form:

Shape: Unknown.

Rims: The three available are slightly thickened and two of them chamfered at outer lip.

Geographical range of type: Fairly abundant in lower and middle (Hurt, MS.) Chattahoochee Valley and in southwestern Georgia.[3] Four sherds were found at Lake Jackson, a Fort Walton site near Tallahassee (Griffin, MS.). One sherd is known for the Gainesville area.[4]

Chronological position of type: By seriation this type is post-Fort Walton.

Relationship of type: Related to Alachua Cob Marked of central Florida and Walnut Roughened of western Georgia.

Sherds, which might have been classified as "Chattahoochee Plain," have been included in site analyses under "Plain, Ft. Walton paste." When the whitish surface color, typical of Chattahoochee Brushed and believed to be the result of a wash, was definitely present, the quantity so affected has been indicated by numbers in parentheses. A similar notation has been used in the case of other types when this color was present.

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[3] Dr. A. R. Kelly, University of Georgia, personal communication.

[4] Collections of the University of Florida, Anthropological laboratory.

Quantities so indicated are minimum as standards were very rigid in respect to this surface condition.

GEOGRAPHICAL BACKGROUND

The lower Chattahoochee River extends 25 miles from its confluence with the Flint north-northwest to the Alabama state line. The 50-foot contour crosses the river about half a mile north of Port Jackson, while the 60-foot contour crosses about a quarter of a mile north of the Alabama line. The gradient of the river is, therefore, 10 feet in $15\frac{1}{2}$ miles. The Chattahoochee carries a heavy burden of clay and sand. The waters of the Flint, by comparison, are much clearer of debris.

The lower Chattahoochee Valley is divided into two zones—bottomlands and uplands. Except at Butler, where the 70-foot contour reaches the river, the 80-foot contour divides these two zones. The 90-foot contour follows the 80-foot fairly closely. In times of flood much of the valley may be under water. High-water mark for the 1929 flood was 89.6 feet north of Sneads and 99.3 feet at Neals Landing Bridge.

Various limestone formations underlie the whole area. These outcrop to the north and east of Sneads, where the 70-, 80-, and 90-foot contours are essentially one. Limestone outcrops again at the Alabama line. Decayed limestone is sometimes found in plowed fields and at other places between these points. These limestones contain chert, which was used by Indians as material out of which to fashion projectile points and other tools. Unless otherwise specified all chips and stone tools mentioned in this paper are made of such chert.

Soil on the uplands consists of coarse sandy loam resting on red clay. This sandy deposit varies considerably in thickness. In places it has eroded entirely away. Over much of the area it forms a thin mantle about 6 inches thick. At site J-3, west of the dam, it is over 2 feet thick. In a few places a good loam has formed, but in general this is not good farmland.

Most of the bottomland is covered with compact clay-silt, which is extremely resistant to tools. Below this clay-silt are sands, clays, and occasionally gravels, which at the site of the dam total 50–80 feet in thickness and rest on bedrock. At some of the slightly higher areas found in the bottomland, such as site J-18, there is a considerable admixture of sand. All such slightly higher land does not contain an appreciable amount of sand. No site was found at which there was not some sand present, although in some cases the sandy zone of occupation was covered by clay-silt.

A significant feature of the bottomland is the natural levee that borders the river. Portions of this levee will be noted on the map (Fig. 1), and more would be evident if the 70-foot contour had been plotted. This levee is not continuous but is an interrupted series of ridges. Varying considerably in width, they consist of stratified sands, clays, silts, and mixtures of these ingredients. Sometimes they contain limonitic zones. Their major component is sand. Frequently tongues of waterlaid sand extend westward from them away from the river.

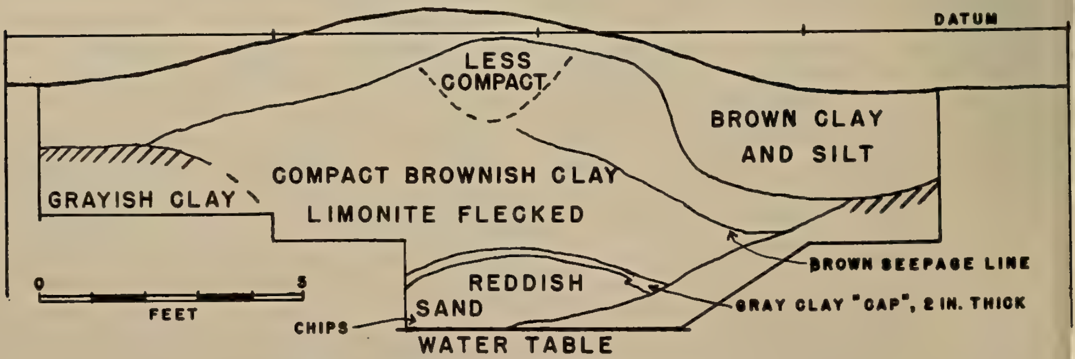

Fig. 2.—Site J-4, Profile of south end of mound.

These present levees are important archeologically because of a series of late sites found buried in them at a depth of 2 to 4 feet. These sites, J-2, 5, 7, 9, 22, 23, and 32, are all of the Fort Walton period, believed to be A.D. 1450–1650.[5] (Site J-10 is similar in time but not buried so deeply, probably because flood waters would flow across it instead of parallel to it, owing to the bend in the river where it is located.)

There are many indications that the Chattahoochee River has not always run in its present channel. Frequently sloughs tend to cut off bends of the river. Suggestions of these will be found on the map. The shape of Pope Lake (A in Fig. 1) and of the 60-foot contour around it are suggestive of an old riverbed. The series of lakes southeast of Butler (C-Gravel Pond, D-Blue Hole, E-Hog Wallow) have a southeasterly curve. They and the ridges south of them (dotted 70-feet contour) may indicate that the river at this point used to flow more to the west. The fact that Gravel Pond used to have a gravel bottom, now covered with silt, supports this theory.

Very early ceramic and preceramic sites, such as have been found on the banks of certain rivers of southeastern United States, notably the Tennessee, were not found on the lower Chattahoochee. It may be that the area did not supply sufficient inducement in the nature of food to attract immigrants in those times. A more likely hypothesis is that a few such early sites are present but were located on old banks now abandoned by the river and buried by subsequent floods.

There is no reason to believe the region would not have supplied adequate food for hunters. Deer, opossums, raccoons, skunks, squirrels, rabbits, turkeys and other birds, snakes, turtles, fishes, and shellfish are found there today. Bears, alligators, and to the north bison are reported by early travelers. No doubt the fauna was more varied in prehistoric times. Nuts, edible roots, and berries, still available, would supplement the diet.

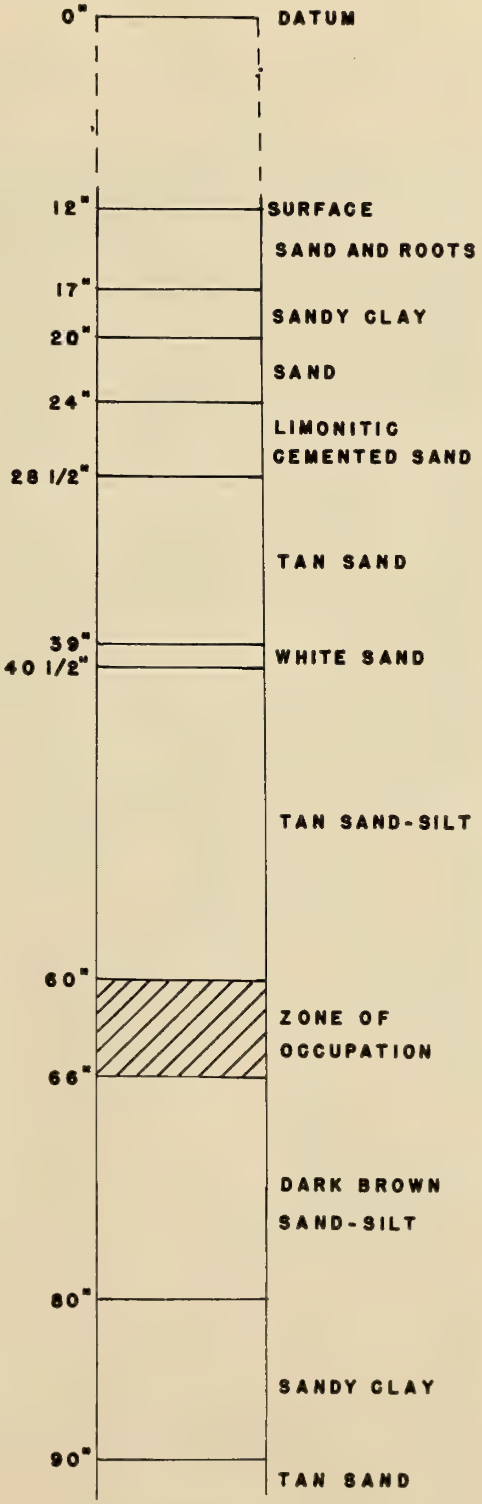

Fig. 3.—Site J-2, west profile of test 2.

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[5] Goggin, 1948b, with minor changes by Bullen.

SUMMARY OF SITES

Sites will be discussed by chronological groups into which they have been divided, according to the ceramic chronology mentioned earlier. Reoccupied sites have been included under the more recent period unless evidence of the earlier one was much more abundant. The first group, consisting of those sites from which an insufficient sample was secured to permit cultural classification, has been designated "Indeterminate."

Indeterminate Sites

Two of the culturally indeterminate sites have mounds. The first, G-1, consists of a small, flat-topped, eroded point of land projecting westerly toward the Apalachicola River. Nearly at the top of the southern slope of this flat land is a clay mound, 15 feet across and 3 feet high. A corner-notched point (similar to Fig. 6, *g*) and chips found on the surface presumably belonged to builders of this mound.

The other mound site, J-4, is located in the bottomland on what appears to be an old river terrace or natural levee, 300 yards west of the present bank of the Apalachicola River. Numerous "mounds," naturally formed about roots of fallen trees, were noted during the survey. Three of the small hillocks at J-4 seemed different. One of the latter, 10 by 15 feet in area and about 30 inches high, was tested by means of a trench, 4 feet wide, dug across the southern end.

Fig. 2 shows a profile from this trench. This profile is not easy to interpret. Away from the mound a layer of brown clay and silt, 15 inches thick, rested on grayish clay. The upper 4 inches of the latter were blackish in color and suggestive of an old land surface. Below the mound there seems to have been some sort of pit. Chips of chert in the dome-shaped deposit of sand and the lack of decayed wood (such as was found in silted windfalls) in the brownish clay support the idea that this is a man-made mound. If the top of the sand deposit had been straight instead of domed, or if it had any of the bandings typical of waterlaid deposits, the profile might be interpreted as representing a buried slough. In that case the chips would be redeposited material.

In any event these data would indicate that man was in the Chattahoochee Valley before the deposition of the upper layer of brown clay and silt. If this deposit could be dated by geological means, an idea of the antiquity of man in the valley might be obtained. When any additional archeological work is done in the area, this mound should be reinvestigated.

Sites G-2 and G-3 are located on old river levees. Each produced chips and a heavy stemmed point. Seven sherds were found by tests in the southern part of G-3, possibly an extension of G-4, the large Fort Walton village and mound group at Chattahoochee Landing.

At J-6 chips, worked fragments, and five Wakulla Check Stamped sherds were collected. Tests at J-27, a slight elevation in the bottomland, produced chips and worked fragments. These chips are similar to those from nearby J-26 in that most are large and a high percentage include the limestone matrix. Both may be quarry sites. J-45 is a small but high sandy knoll. Here two sherds of Plain, Fort Walton paste were found in a test hole, but additional tests failed to uncover more.

J-41, an eroded area along the road, is of interest because of possible association between heavy stemmed points and pottery. Sherds are tempered with very fine sand. One, badly eroded, may once have been simple stamped. Another is a thick, crude-appearing rim exhibiting what appears to be a Deptford simple stamp. Rim treatment is reminiscent of Franklin Plain.

Little can be said about other sites in this group. All are areas where Indian material had eroded from the thin sandy mantle that covers the red clay. J-33 produced one Wakulla Check Stamped and 12 residual plain sherds; J-34, chips, one Wakulla Check Stamped and 3 plain, sand-tempered sherds; J-36, chips, a rough triangular blade, and two plain, sand-tempered sherds. J-8, J-11, J-13, J-14, J-15, J-16, J-21, and J-24 produced only chips and worked fragments. At J-19 two heavy stemmed points but no chips were found. J-14 is unique as a piece of burnt daub was found there. Some of these sites may represent preceramic occupation of the valley.

Santa Rosa–Swift Creek Sites

Two sites are included here for this period. Reoccupied Santa Rosa–Swift Creek sites will be found among Leon-Jefferson sites (J-3) and among Lower Creek (?) sites (J-46, J-47, and probably J-50).

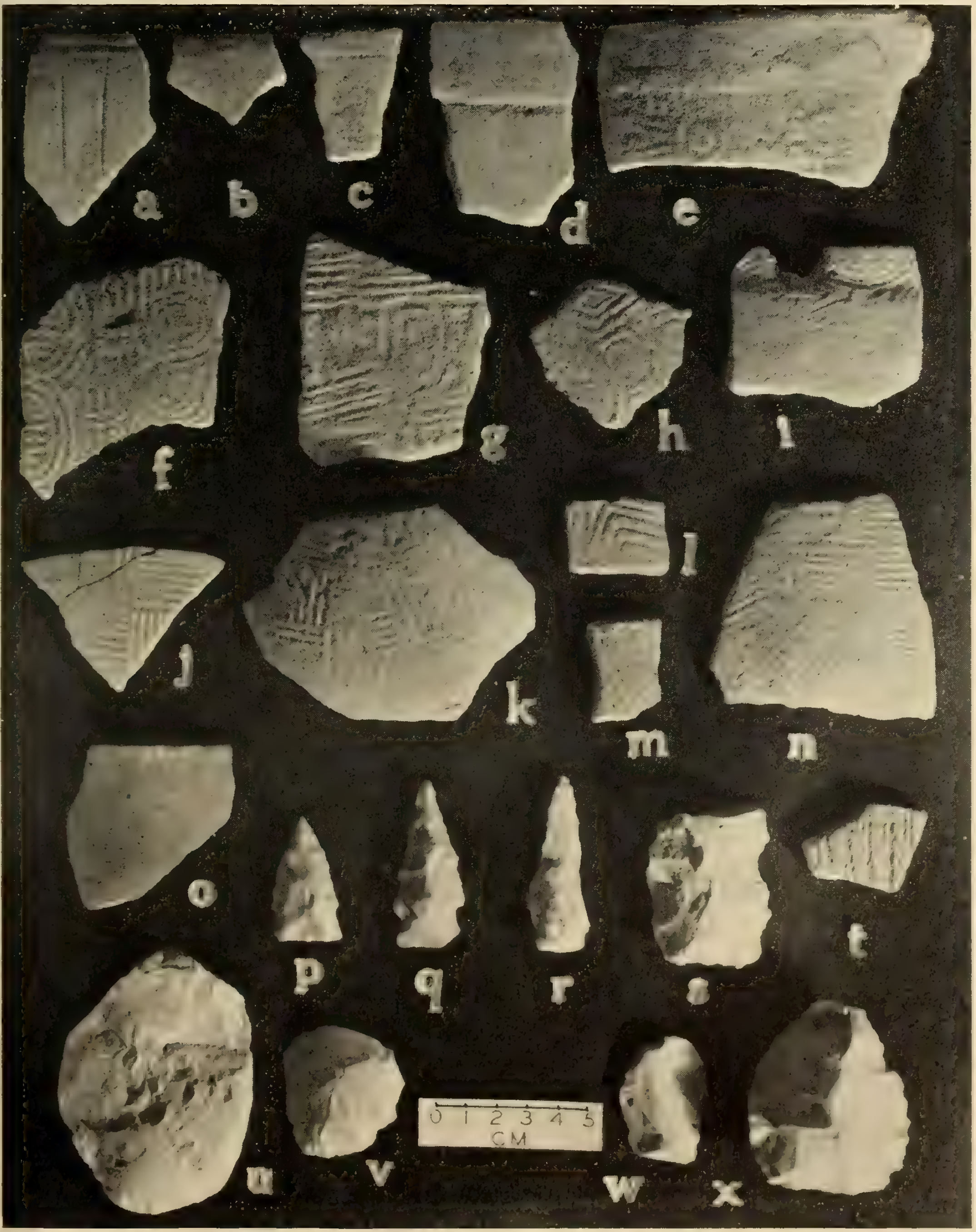

FIG. 4.—Specimens from Tan Vat site, J-18: *a*, Carrabelle Incised; *b*, Plain, incurving rim; *c*, *d*, Weeden Island Plain; *e–i*, Swift Creek Complicated Stamped (*e*, late; *i*, early); *j*, *k*, St. Andrews Complicated Stamped; *l*, Crooked River Complicated Stamped; *m*, *n*, Gulf Check Stamped; *o*, Franklin Plain; *p–r*, projectile points; *s*, fragment of knife; *t*, West Florida Cord Marked; *u*, hammerstone; *v*, *w*, utilized chaips; *x*, rough trianguloid blade.

J-18 or the Tan Vat site is a small undisturbed village of the very late Santa Rosa–Swift Creek period. It is located on a low knoll in the bottomland of the eastern side of Tan Vat Pond, which may have been the channel of the Chattahoochee River when the site was occupied (Fig. 1).

The profile consisted of brown sandy clay underlaid by compact grayish-yellow clay. The superior zone varied from 6 to 16 inches in thickness, depending on the elevation of the surface. Where thick it could be divided into two parts—an upper sterile portion 6 inches thick and a lower zone of occupation 8–10 inches thick.

Two stratigraphic tests, one 4 by 4 and the other 5 by 5 feet, were troweled in this midden using arbitrary levels. The site seemed homogeneous, but Carrabelle Incised, plain incurving rims, and thickened rims on Swift Creek Complicated Stamped sherds (Fig. 4, *a*, *e*) were found only in the upper part of occupational deposits.

Specimens from this site, illustrated in Fig. 4, include 4 Weeden Island Plain, 1 Carrabelle Incised, 35 early type and 6 late type Swift Creek Complicated Stamped, 7 early type and 2 late type St. Andrews Complicated Stamped, 2 early type Crooked River Complicated Stamped, 1 early type West Florida Cord Marked, 23 Gulf Check Stamped, 1 Franklin Plain, 39 indistinct stamped, 1 miscellaneous incised, and 164 plain, sand-tempered sherds; 454 chips, 1 core, 2 utilized flakes, 3 worked fragments, 2 hammerstones, 1 rough, thick, trianguloid blade, and 3 side-notched projectile points. Two fragments of quartz pebbles, 2 broken rocks, some fragments of calcined bone, and a piece of charred worked wood complete the available inventory.

Pottery from this site is representative of very late Santa Rosa–Swift Creek at a time when ceramic development was tending strongly toward Weeden Island. Exterior folded or thickened rims, usually considered typical of Weeden Island, are first found in a Santa Rosa–Swift Creek context (Willey and Woodbury, 1942, p. 241), while there is unpublished evidence that an early form of Carrabelle Incised is present in pre-Weeden Island times.[6] Weeden Island Plain rims are not so well smoothed as they are at Weeden Island sites (compare Fig. 4, *c*, *d*, with Fig. 5, *a*, *b*). Sherds from the Tan Vat site contain mica inclusions in their paste.

Attention is called to the three projectile points (Fig. 4, *p*–*r*). It will be noted that two of them are similar in having shallow side notches. The third, while unfinished, suggests the same form. This is the first recorded instance in which projectile points have been definitely associated with Santa Rosa–Swift Creek pottery in Florida.

The Tan Vat site may be the village of Indians who built a mound leveled by Moore in 1906. Moore placed his "Mound near Kemp's Landing" one mile south-southeast of that landing (J-10 on map). This would locate it about half a mile southeast of the Tan Vat, but search did not reveal its location.

Regarding a large deposit of pottery found in the eastern part of this mound, Moore (1907, pp. 428–429) wrote, "Decoration, when present, consists of the small check stamp; the complicated stamp, faintly impressed; very rude incised line decoration in two instances in sherds; in one case an incised decoration of wavy lines and punctate markings as shown in Fig. 1." Except for the one vessell illustrated by Moore, which is a divergent variety of Indian Pass Incised, this description would apply to pottery from the Tan Vat site.

Site J-26 has been assigned to a Santa Rosa–Swift Creek time horizon on the basis of a single St. Andrews Complicated Stamped sherd. Such designation is, of course, subject to question. The site is located on a slight rise of the bottomland adjacent to a small lime sink (Fig. 1).

Four tests were dug covering 40 square feet. Profiles showed a surface zone of sterile reddish brown clay, 12 inches thick; next, brown sandy clay, 6 inches thick, containing chips, bits of charcoal, and the one sherd; thirdly, clayey sand, 22 inches thick, in the lower 16 inches of which chips and rarely charcoal were found; and finally compact red clay.

Though this profile might infer a preceramic zone, such seems dubious in view of the lack of artifacts and the character of the chips. Most chips were large and 40 per cent included the lime matrix. At the Tan Vat site a majority were small and only 10 per cent exhibited this matrix. It seems reasonable to believe J-26 to be the remains of Indian exploitation of the supply of chert which might be found at a lime sink.

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[6] John W. Griffin, personal communication.

Weeden Island Sites

Table 1 lists material from eleven sites considered to belong to a Weeden Island horizon. One Lower Creek (?) site, J-48, was also occupied by Weeden Island people.

In some cases, particularly J-25 and J-35, allocation is based on a minimum of evidence as Wakulla check stamped pottery is fairly common at Fort Walton sites in this area. In these cases some consideration has been given to lack of mica in pottery paste. As will be seen, mica is prominent in Fort Walton pottery of the lower Chattahoochee valley.

Table 1.—Material from 11 Weeden Island Sites

Specimens	J-12	J-17	J-20	J-25	J-31	J-35	J-37	J-38	J-39	J-40	J-44
Chert:											
Chips	80	310	3	47	131	19	150	4	5	23	26
Cores		5			2						
Utilized flakes		2			6						
Worked fragments		8	1	2	10		2				1
Tools, see lists in text		16	1		14		2				
Quartz:											
Chips							1				1
Fragments of pebbles		4		1		1				1	
Hammerstones		3		1							
Quartzite:											
Broken fragments		2									
Hammerstones		1									
Hematite											1
Steatite					3		1				
Shells:											
Fresh-water snails								x		x	
Fresh-water clams		x							x	x	
Busycon		1									
Pottery:											
Weeden Island Red		5						1			
Weeden Island Incised		1			1						
Weeden Island Punctated		4									
Weeden Island Plain	2	39						1			2
Carrabelle Incised	2	12	4								1
Carrabelle Punctated	2	9			1			1	1		1
Swift Creek Complicated Stamped (Late)		24	1								1
Keith Incised		6									
Wakulla Check Stamped		92		26		16	2	13	24	13	
Miscellaneous:											
Incised		5		1							
Punctated		9			1						
Stamped		15						5		1	1
Cord-marked		1									
Smooth Plain		167					16	3	3	5	16
Plain, sand-tempered	23	300	28	93	10	13	1	33	10	5	8
Roughened surface, Fort Walton paste		39 (2)							2		
Plain, Fort Walton paste		32 (4)		5 (5)	1	1			1		
Total Sherds	29	760	33	125	14	30	19	57	41	24	30
Pottery disk		1									
English stoneware, early nineteenth century				10							

x—present in fair quantities.

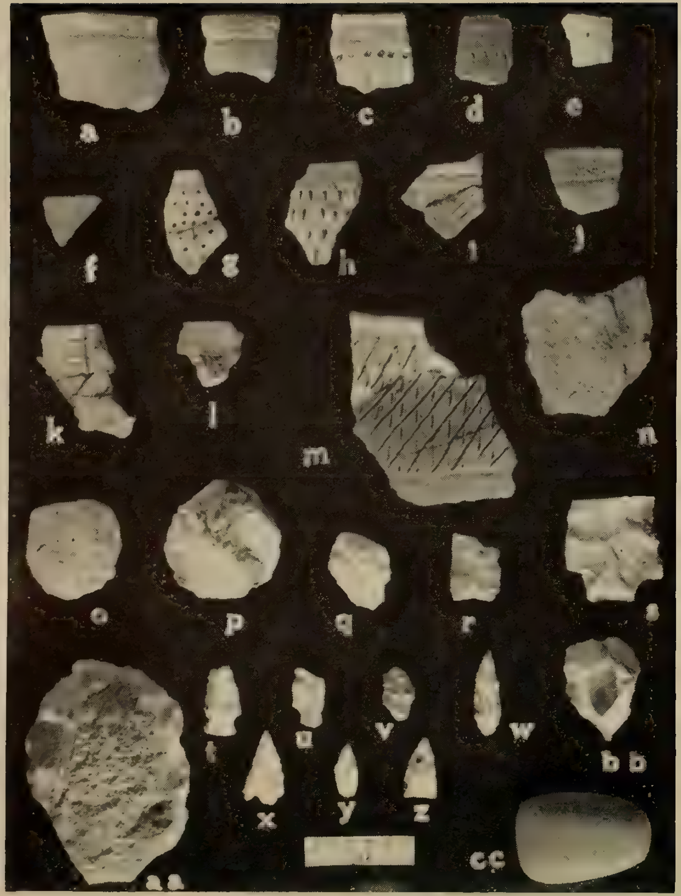

FIG. 5.—Specimens from Butler site, J-17: *a*, *b*, Weeden Island Plain; *c–e*, Weeden Island Punctated; *f*, Weeden Island Incised; *g*, *h*, Carrabelle Punctated; *i*, Carrabelle Incised; *j*, Wakulla Check Stamped; *k*, *l*, Swift Creek Complicated Stamped (Late Variety); *m*, Keith Incised; *n*, roughened surface, Fort Walton paste; *o*, pottery disk; *p*, chipped chert disk; *q*, utilized flake; *r*, fragment of asymmetric trianguloid knife; *s*, fragment of stemmed knife; *t–z*, projectile points; *aa*, hoelike tool; *bb*, scraper, *cc*, celt.

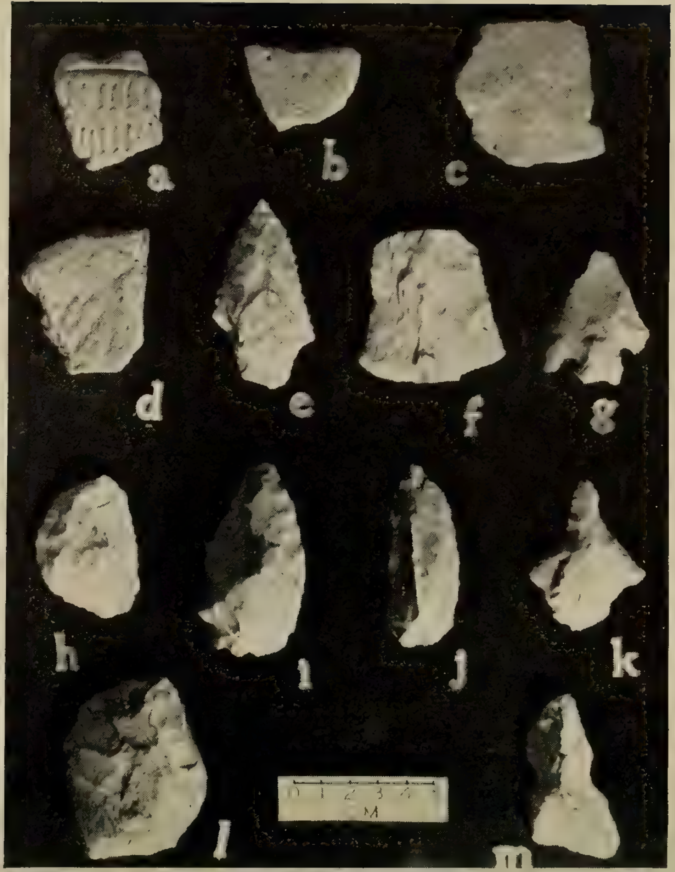

FIG. 6.—Specimens from Wilson site, J-31: *a*, Carrabelle Punctated; *b*, Weeden Island Punctated; *c*, Plain, sand-tempered; *d*, fragment of steatite vessel; *e*, *g*, projectile points; *f*, fragment of stemmed knife; *h*, *l*, ovate scrapers or knives; *i*, unfinished tool; *j*, side scraper; *k*, drill; *m*, shaft scraper.

Material listed for J-12 came from a small knoll in a plowed field.

The Butler site or J-17 is the largest and most important of the Weeden Island group. Owing to the presence of Wakulla Check Stamped sherds, it must be considered reresentative of Weeden Island II. Fig. 5 shows some of the specimens collected.

This site is located on the upland, one-half mile south-southeast of Butler, on the top and eastern slope of a low ridge. At the foot of the slope is a large water hole which, in recent years at lest, has never run dry and is, presumedly, spring fed. About 3 acres of this slope is littered with sherds, chips, tools, and fresh-water clam shells. Soil consists of dark brown, coarse sandy loam resting on coarse reddish sand. Unfortunately, long cultivation with attendant slope wash has completely ruined this midden for scientific excavation.

Stone tools, in addition to those listed in the foregoing tabulation, include another hammerstone (not illustrated), a chipped disk, an asymmetric trianguloid knife, a large stemmed knife, seven projectile points, a hoe-like tool, three scrapers, all of chert, and a polished celt of granite (Fig. 5, *p*, *r-cc*, respectively). The latter, or the material for it, must have been imported into Florida as granite is not a native rock.

One of the projectile points (Fig. 5, *t*) is side notched and of the same type as those found at the Santa Rosa–Swift Creek Tan Vat site, J-18 (compare with Fig. 4, *q*). Shapes of the others may be noted from the illustration. Their relatively small size, 1–2 inches in length, implies use of the bow and arrow by Weeden Island II times.

Relatively large amount of late Swift Creek Complicated Stamped sherds may indicate this type to persist later in the Chattahoochee Valley than near the coast where Willey and Woodbury made their tests. Lack of other Weeden Island I complicated stamped sherds is to be noted.

Slightly less than 10 percent of the sherds from the Butler site have been classified as having been made of Fort Walton paste. These may represent inferior workmanship, as the paste of some of these sherds is not markedly different from that of some sherds decorated in typically Weeden Island style. On the other hand, presence of a small number of sherds with a whitish surface, while statistically insignificant, may indicate use of this site during Lower Creek (?) times.

At J-20 chips and sherds were found on the eroded surface of a road. The lower part of a pit, dug into the now exposed red clay, was noted.

At J-25 chips and sherds had eroded out of sandy clay which overlaid red clay, on both sides of an erosion gully. Also on the eroded surface were parts of a cast-iron stove, sherds of the early nineteenth century, English stoneware (blue-edged and blue on white Staffordshire), fragments of old glass bottles, and part of a modern glass tumbler. The latter was probably from a nearby cabin.

All aboriginal sherds from this site, except the five Plain, Fort Walton paste, are substantially eroded. These five are not eroded and, as indicated in the table, have the whitish surface color characteristic of Chattahoochee Brushed. This pottery is believed to be post-Fort Walton in date and to represent a Lower Creek (?) component. As will be explained later, J-25 is in the area occupied from about 1819 to 1838 by a group of Indians under Econchatimico. Blue-edged Staffordshire was made in England after about 1810. There is the possibility, therefore, that the English stoneware and perhaps the whitish aboriginal ware were used by some of Econchatimico's people.

Specimens from J-31, the Wilson site, were found on the eroded red clay slope of a ridge on the uplands adjacent to a dry brook bed. While the sample is small, sherds have a paste similar to that of pottery from the Tan Vat site (Santa Rosa-Swift Creek). This detail and the lack of Wakulla Check Stamped sherds implies that this site is Weeden Island I in date. Specimens are illustrated in Fig. 6.

To judge from available samples, there seem to be differences in types of projectile points from this site compared with those from the Butler site, J-17 (compare Figs. 5 and 6). Perhaps the bow was not in general use until Weeden Island II times. Chert specimens, other than those listed in Table 1, include a heavy (thick) stemmed point with serrated edges, a fragmentary knife or lance point, two points with deep corner notches, two thin ovate knives or scrapers, an unfinished blade, three side scrapers, a drill, two thick ovate scrapers, and a shaft scraper (Fig. 6, *e–m*, respectively). Notches at the sides of the latter are worked.

J-35 is a cultivated field, now overgrown with trees, on an early river levee or terrace in the bottomland.

J-37 is on a little rise in the bottom land. The profile, from top to bottom, consisted of black-brown coarse sand, 10 inches thick, in the lower 3 inches of which chips and sherds were found; brown coarse sand, 12 inches thick, which also contained chips and sherds; a tan or slightly mottled zone of coarse sand, 18 inches thick, which contained chips and pits and post holes (?) extending downward from the zone above; and, finally, coarse limonitic cemented sand in one test, coarse white sand in the other.

There was no difference in sherds from the lower part of the black-brown sand. A large blade, 4½ by 2 inches, was found at a depth of 18–20 inches in the lower part of the brown sand and the basal portion of a stemmed point at a depth of 53 inches in what appeared to be an old burned-out stump.

Area covered by tests was not sufficient to decide if this site had a preceramic zone. Many of the chips included the limestone matrix. Immediately south of J-37, lime-

TABLE 2.—MATERIAL FROM 9 FORT WALTON SITES

Specimens	G-4	J-2	J-5	J-7	J-9	J-10	J-22	J-23	J-32
Chert:									
Chips	184	47	10				1	4	1
Worked fragments	7								
Quartz:									
Chips		2	1						
Fragments of pebbles	7	2							
Hammerstones			1						
Charred corn cob			1						
Pottery:									
Chattahoochee Brushed	2(1)	3(1)						10	
Alachua Cob Marked	4							2	
Combination Cob Marked and Wakulla Check Stamped								1	
Miller Plain	7								
Lamar Complicated Stamped(?)				1					
Fort Walton Incised	1	42	5	1		1		5	6
Pinellas Incised, B		16	3						
Lake Jackson Fingernail Impressed (?)		1	1						
Combination Pinellas Incised and Lake Jackson Fingernail Impressed(?)		1							
Lake Jackson Plain		7	2(1)					1	
Wakulla Check Stamped	45	36	32	1	4	9	8	10	
Plain, Fort Walton paste	118(8)	755	164	8	4	32	6	47	31
Notched rims, Fort Walton paste		26	4					1	2
Handles, Fort Walton paste		2	2						
Miscellaneous:									
Burnished surface		13	2						
Fine incised festoons and guilloches		2							
Incised	3	13	3		1			3	1
Punctated		3							
Cord or textile impressed	2								
Stamped	8	3							
Large check stamped	1							1	1
Roughened surface	8	11		2		1			1
Pensacola Incised				1					
Plain, shell-tempered		3	3	2				3	5
Plain, limestone-tempered	2	1	3						
Rim sherd with node, 1½ inches below rim					1				
Deptford Simple Stamped(?)		1							
Gulf Check Stamped		3	1						
Tetrapod, Gulf Check Stamped		1	1						
Combination Gulf Check and Swift Creek Complicated Stamped		1							
Plain, sand-tempered	8	12	8						
TOTAL SHERDS	209	956	234	16	10	43	14	84	47

stone containing chert nodules outcrops above the 80-foot contour (at J-19). Quarried material brought to the Harrell site could be mixed to considerable depths in coarse sand by aboriginal disturbance.

J-38 and J-39 probably refer to parts of the same site as they are located on opposite sides of a small brook. These locations are cultivated fields, fallow at the time of the survey. They are said to have produced many Indian artifacts. Snail shells are *Campeloma ponderosum* Say.[7] Tests indicated no aboriginal remains below the plowed zone.

J-40 is another old cultivated field, now in high grass and small pines. Snails are *Campeloma ponderosum* Say.

Trees and patches of grass cover J-44, which is located on what seems to be an old river terrace. Specimens were excavated from a blackish-brown occupation zone, 6 inches thick, the top of which was 8 inches below the surface. Above and below this zone was brown, medium coarse sand. This site appeared to cover several acres but no concentration was located.

Fort Walton Sites

Material from nine Fort Walton sites is listed in Table 2. Examination of the map will show that all are located on present river banks.

Chattahoochee Landing (G-4 in Fig. 1) on the east bank of the Apalachicola River, just south of Route 90, was visited by Moore in 1902. He reports a total of seven mounds, all of the residential type. The largest, at the time of his visit supported several frame buildings (Moore, 1903, pp. 491–492). This is probably the same one which in 1838 was the location of a tavern (de Castelnau, 1948, p. 206).

Today, five mounds and a midden or Indian refuse deposit, about 30 inches thick, may be seen at the landing. These mounds are of the flat-topped, platform type built by Indians as foundations for buildings. They vary from 30 to 80 feet across and from 5 to 20 feet in height, approximately. One has a trench, 20 feet wide, dug, presumedly by Moore, through its central portion.

Sherds from the mound group and midden were segregated by areas but significant differences did not appear from this analysis. Many Wakulla Check Stamped sherds from this site have a distinct linearity to the stamping. Included under "Miscellaneous, stamped" are five which would be called Deptford Linear Check Stamped except that they are made of Fort Walton paste. Some micaceous paste is included in the collection.

The Jim Woodruff site, or J-2, is located where the dam meets the west bank of the Apalachicola River. Here the natural levee is about 150 feet wide. Occupation extended 650 feet along this levee and from the river bank at least 65 feet to the west. A small slough used to cross the site, draining lower land to the west. Slope of the occupation zone near this slough indicates it was present during Indian habitation. Thus the Jim Woodruff site offered Indians plenty of land for agriculture and potable water other than the Apalachicola River. The slough would also be a convenient place at which to draw up canoes.

Specimens, illustrated in Fig. 7, came from three places; the eroded bank of the river, an area from which the overburden had been removed by bulldozers, and tests dug during the survey. It is probably significant that no early sherds (Deptford and Gulf Check Stamped, Fig. 7, *w–z*) were found in tests.

Occupational debris are buried under 4 feet of more recent alluvium. This is considerable when it is remembered that this site is relatively late, circa 1600. Profiles varied from test to test in respect to sand and sandy deposits in the upper portion of overburden. Fig. 3 shows the west profile from test 2. Sediments of the zone of occupation did not differ from those immediately above or below, except for being darkened by charcoal and, presumedly, nitrogenous material.

The fact that habitational debris were found in the middle of a sand-silt zone is important. This same zone was found at many places along the Chattahoochee River. All Fort Walton sites to be mentioned, except J-10, were similarly situated in this sand-silt stratum. This implies that they were all established at about the same time, after the deposition of this zone had started, and were all abandoned before this particu-

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[7] Kindly identified by William J. Clench, Museum of Comparative Zoology, Cambridge, Mass.

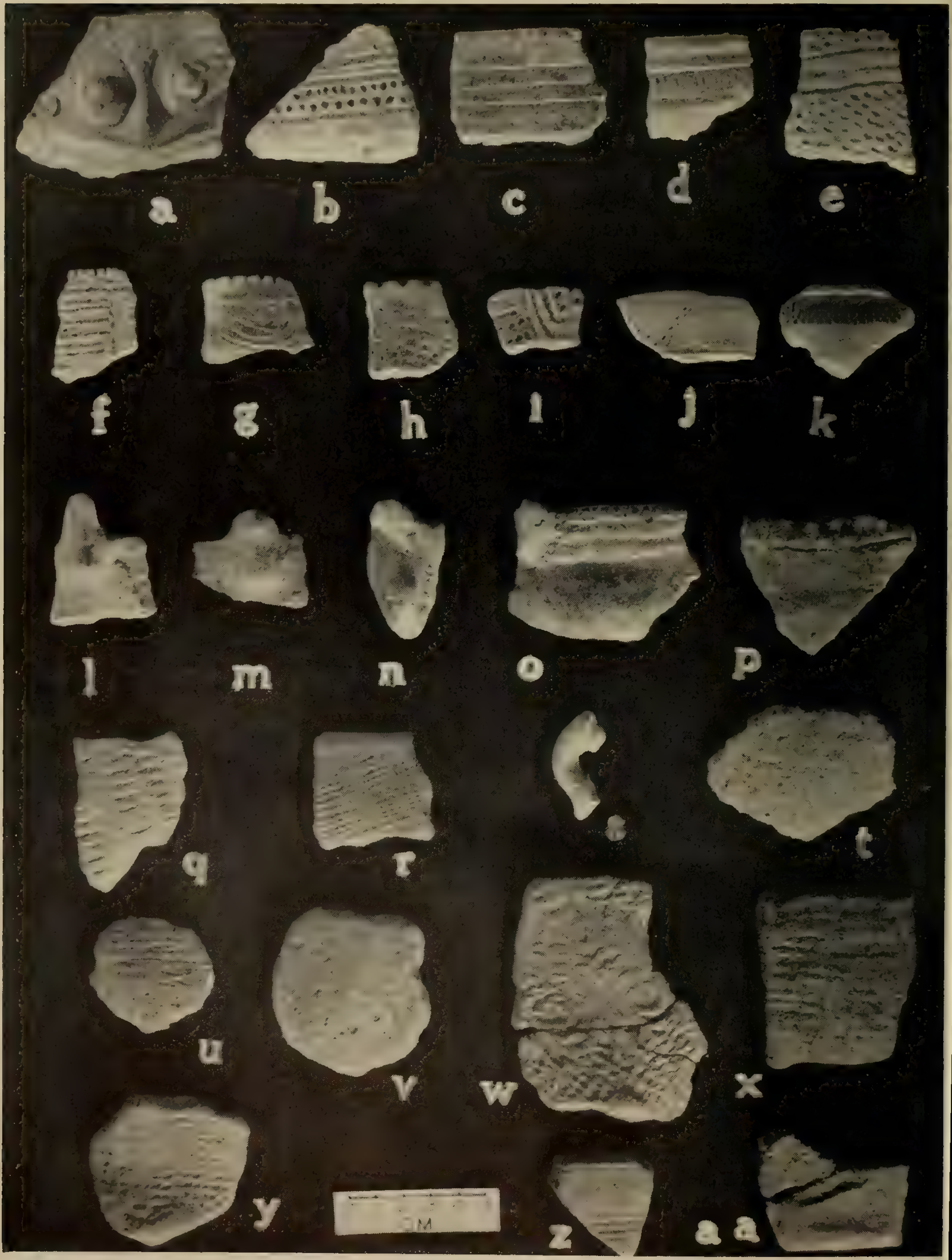

FIG. 7.—Specimens from Jim Woodruff site, J-2: *a–k*, *p*, Fort Walton Incised; *l–n*, Lake Jackson Plain; *o*, Pinellas Incised; *q*, Lake Jackson Fingernail Impressed (?); *r*, Wakulla Check Stamped; *s*, handle; *t*, roughened surface; *u*, pottery disk, scored surface; *v*, pottery disk, shell-tempered; *w*, combination Gulf Check and Swift Creek Complicated Stamped; *x*, *y*, Gulf Check Stamped; *z*, Deptford Simple Stamped; *aa*, hone.

lar deposition was completed. It is also undoubtedly true that this deposit formed excellent agricultural land.

At some of the natural levees of the lower Chattahoochee River a sand-silt zone was not found. Opposite Rambo Island and at Neals Landing recently(?) deposited layers of sand, clayey sand, and, occasionally, clay reach a total thickness of ten feet. Both a sand-silt deposit and evidence of Indian occupation were absent at such places.

Occupational debris at the Jim Woodruff site produced many sherds, much charcoal, occasional bits of calcined bone, and a few chips. Scarcity of the latter implies a much greater dependence on agriculture for food than in the case of Santa Rosa-Swift Creek and Weeden Island sites previously described. Not included in Table 2 are fragments of sandstone, a sandstone hone (Fig. 7, *aa*), and three disks made from sherds. One disk had a scored surface and another was shell-tempered (Fig. 7, *u–v*).

North of the dam a section, 15 feet long, was cleared. In this face two post holes and two small pits could be seen. Two pieces of clay daub from house walls, exhibiting concave surfaces, were also found. Undoubtedly, Indians had houses at this site.

In one test, 5 by 10 feet, which produced 298 sherds, the zone of occupation was removed in two arbitrary layers. Significant differences were not sharp but it is worthwhile to record that four Lake Jackson Plain, one Wakulla Check Stamped, a shell-tempered sherd, one with fine incised festoons and another with fine incised guilloches were in the upper half. Fort Walton Incised and Pinellas Incised B were in both zones. The face of a frog effigy vessel (Fig. 7, *a*) was in the lower half. Similar relatively shallow and, presumedly, relatively late provenience for the first three items will be mentioned later for two other Fort Walton sites.

All except shell-, sand-, and limestone-tempered sherds contained mica in their paste. A comparison of the ceramic inventory from the Jim Woodruff site with that from Chattahoochee Landing indicates certain similarities and differences. The latter undoubtedly reflect the sizes of the respective samples.

J-5 is comparable to the Jim Woodruff site in many ways. It is, however, much smaller, as the levee is only about 50 feet wide. As before, the habitation zone, 8 inches thick, is the central portion of a dark brown sand-silt stratum. Overburden is only 34 inches instead of 4 feet thick. Twenty-six different layers of sands and clayey sands were counted in this overburden.

Three tests, totaling 35 square feet, were dug and specimens removed by arbitrary levels. As at the Jim Woodruff site, Lake Jackson Plain and shell-tempered sherds were limited to the upper half. Wakulla Check Stamped sherds were found in both zones.

The ceramic inventory from this site parallels that from the Jim Woodruff site very closely. Most sherds contain micaceous paste. Evidence was also found for two shallow pits and four post holes. The latter, 8 inches in diameter, extended 9 inches below the habitation zone and, while not forming a straight line, roughly paralleled the river bank.

At this site we do not have to imply agriculture from the small number of chips, as a charred ear of corn was found. This is the first aboriginal corn known to science from Florida. Deer bones and fresh water clam shells testified to other sources of food. A fragment of polished stone, possibly part of an ornament, was also found.

What appeared to be a small mound was found about 120 feet north of tests made at J-5. A trench proved this to be a natural accumulation of dirt around the roots of a tree that had fallen toward the river. The charred trunk, buried under 20 inches of waterlaid sand, appeared to be that of a water oak. From slope of strata and from a downward dip in the Indian habitation zone, it appeared that the bank of the river, at this point, had moved eastward 21 feet since occupancy of this site.

Three of the "Plain, sand-tempered" and both the body and tetrapod Gulf Check Stamped sherds, shown in Table 2 for this site, were found in association with the disturbance caused by this tree.

Site J-7 is smaller than the two previous ones. As before, the zone of occupation, 6 inches thick, is in the center of a brown sand-silt deposit. Overburden is 30 inches thick. All sherds, including sand-tempered ones, have mica particles in them.

The situation at J-9 is similar to that at those just mentioned. Waterlaid sands and clayey sands, 27 inches thick, overlay brown sand-silt. The habitation zone, only 4 inches thick and relatively unproductive, was 14 inches below the top of the sand-silt. All sherds contain micaceous inclusions.

At Kemps Landing, where J-10 is located, the geological situation is radically different. Laminated sands and clayey sands are not present. Presumedly, this is because flood waters would tend to erode rather than deposit due to the bend in the river.

The site is located on what appears to be part of an old river terrace. At the site this terrace is composed of a brown clay-silt zone, 16 inches thick, which contains some sand and rests on red clay. The lower part, between depths of 8 and 15 inches, is darkened by charcoal and contains a few chips and sherds having micaceous paste. A late nineteenth-century nail was found in the upper 4 inches of one test.

At Butlers Ferry, where J-22 is located, there has been a lot of activity by settlers during the last 100 years. Profiles differed substantially from test to test.

In one test Indian items were found in the

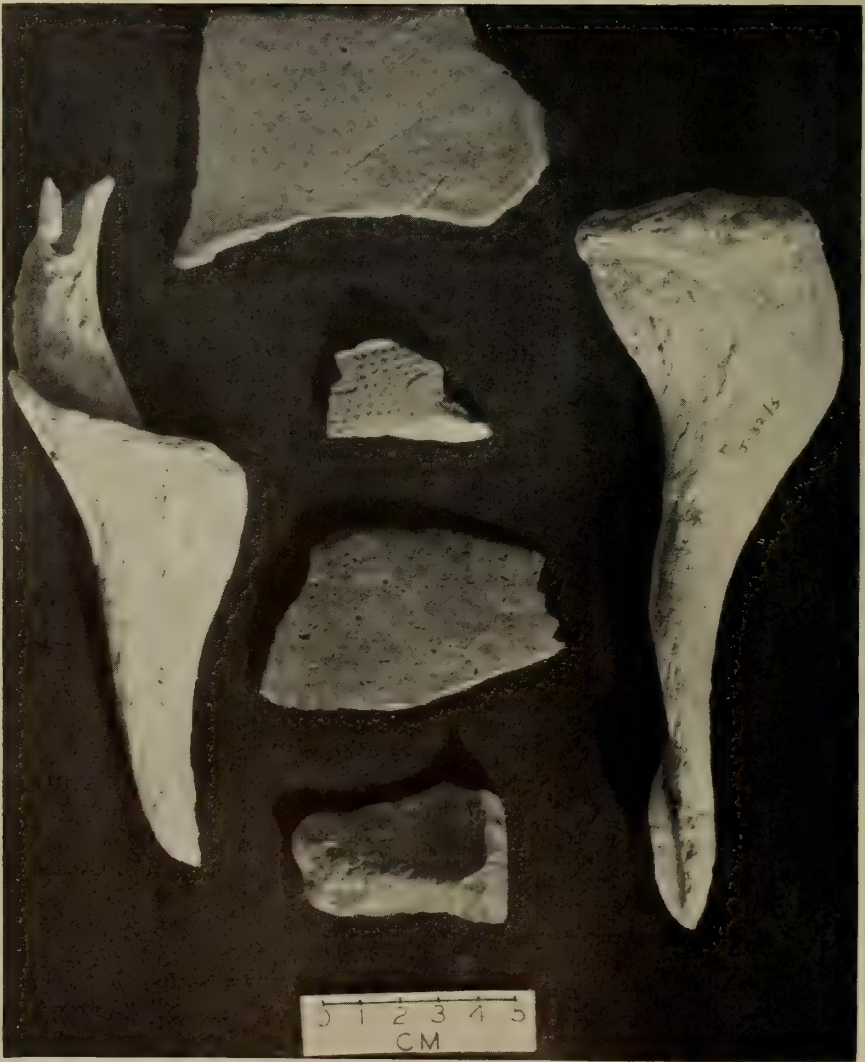

Fig. 8.—Specimens from Bellamy site, J-32: Sides, fragments of *Busycon* shells; top sherd, Plain, Fort Walton paste; middle sherd, Fort Walton Incised; lower sherd, Plain, shell-tempered; bottom, patinated flint tool.

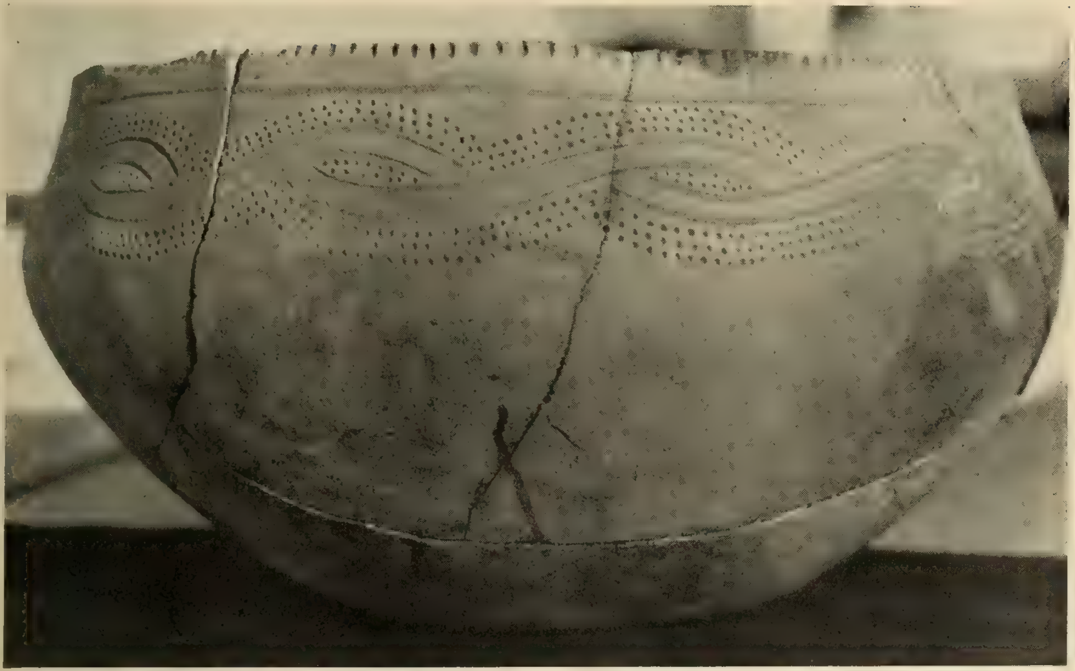

Fig. 9.—Restored Fort Walton Incised vessel from Bellamy site, J-32.

middle of a dark brown silty zone, 13 inches thick, which was overlaid by 18 inches of waterlaid sands and clayey sands. In the latter, at a depth of 12 inches, some charcoal was found. This charcoal can be correlated with recent activities as nails, iron, and fragments of glass bottles were found at the same relative position in other tests.

At J-23 evidence of two sequential occupations, both during the Fort Walton period were discovered. The levee is about 30 feet high and rather broad. These seem to be desirable features of a site. It is not surprising that the amount of Indian debris is reminiscent of the Jim Woodruff and J-5 sites where these features were also present.

The profile consisted of laminated yellow or red sands, 23 inches thick; a zone of brown silty sand, 17 inches thick; and, at the bottom of test holes, gray sand. The lowest 3 inches of brown silty sand formed the lower occupation zone. A sterile zone, 3 inches thick separated it from a superior occupation zone, 5 inches thick.

Here, as at the Jim Woodruff and J-5 sites, Lake Jackson Plain and shell-tempered sherds were found only in the upper zone. All, except Chattahoochee Brushed, cob-marked, and shell-tempered sherds have micaceous paste. Attention is called to the combination cob-marked and Wakulla Check Stamped sherd listed in Table 2 for this site.

J-32 is the most northern Fort Walton site located by the survey. As usual, occupational debris were found in a zone, in this case 8 inches thick, which formed the mid-portion of a brown sand-silt deposit. This deposit, 21 inches thick, rested on gray sand and was overlain by yellow and white sands and clayey sands totaling 21 inches in thickness.

Tests uncovered what may have been a "ceremonial" deposit. Large sherds of a restorable Fort Walton Incised vessel (Fig. 9), overlapping each other, were found inverted over a small deposit of bones. Two *Busycon* shells (Fig. 8) had been placed on top of these sherds. At the base of the "cache," possibly fortuitiously, were a retouched, patinated flint tool (Fig. 8), four Plain, Fort Walton paste, and two shell-tempered sherds. The only preservable bone was a rib, similar to that of a small deer. In the dark, charcoal-impregnated midden, it was impossible to determine whether or not this "ceremonial" deposit was intentionally placed in a shallow pit. Slight changes in color, here and there, suggested such to have been the case.

At this site some mica was found in all sherds, including shell-tempered ones.

Leon-Jefferson Sites

Two sites have been assigned to the Leon-Jefferson period based upon surface collections. The lack of many Fort Walton pottery types in their inventories should be noted. In contra-distinction to Fort Walton sites of this area, mica is present only in Wakulla Check Stamped, Swift Creek Complicated Stamped, and simple stamped sherds. Examination of the lists will indicate that 18 percent of all sherds, 29 percent if sand-tempered sherds are eliminated (presumedly, they belong to an earlier period), have a whitish surface color. Application of this wash(?) is not limited to any specific pottery type.

Site J-1 occupied a knoll, on the uplands, which had been leveled in connection with building operations. Soil consisted of very coarse sand. The available inventory includes: 1 Ocmulgee Fields Incised, 1 Jefferson ware rim, 3 Miller Plain, 13(4) Plain, Fort Walton paste, and 4 Plain, shell-tempered sherds; 20 chips, 2 utilized flakes, and 1 worked fragment.

Site J-3 covers about ten acres on land of the State Hospital Farm. As at J-1, the chief constituent of soil is coarse sand. Specimens, illustrated in Figure 10, include: 22(8) Chattahoochee Brushed, 4 Alachua Cob Marked, 1 Cob Marked over Chattahoochee Brushed, 3 Spanish, 6 Mission Red Filmed, 19(13) Ocmulgee Fields Incised, 9(6) Jefferson Ware Rims, 8(4) San Marces Stamped (Cross Simple), 1 Aucilla Incised (limestone-tempered), 31 Miller Plain, 2 Lake Jackson Plain, 47 Wakulla Check Stamped, 157(65) Plain, Fort Walton paste, 6(6) interior red painted, 1 scored interior red painted, 19(7) Walnut Roughened, 16 miscellaneous incised and stamped, 2 scored, shell-tempered, 21 plain, shell-tempered, 9(5) plain, limestone-tempered, 13 Deptford Simple Stamped, 37 Swift Creek Complicated Stamped, and 193 Plain, sand-tempered sherds; 199 chips, 4 worked fragments, 2 scrapers, 4 projectile points, 1 chipped hoelike tool, a quartz hammerstone, and limestone hone.

Spanish, Mission Red Filmed, and other sherds date occupation by Indians as roughly contemporaneous with Spanish missions near Tallahassee where similar pottery has been found, circa 1633–1704 (Smith, 1948, pp. 316–318). Bishop Calderón of Cuba in a letter to the Queen of Spain states that a mission was established on the upper Apalachicola River in 1675 (Wenhold, 1938, p. 9). It may have been at site J-3. Indians may have continued living here after mission times. The pottery inventory also indicates an occupation during the Santa Rosa–Swift Creek period.

Presence of two Lake Jackson Plain sherds is interesting. As has been mentioned in the preceding section, Lake Jackson Plain, albeit in small quantities, was found only in the upper zones of three Fort Walton sites along the Chattahoochee River. It is not surprising, therefore, to find it here at a site whose major occupation occurred during the succeeding period. This occurrence tends to confirm the stratigraphic evidence that Lake Jackson Plain is a very late Fort Walton pottery type.

Wakulla Check Stamped sherds and some of the projectile points are suggestive of Weeden Island. Lack of other Weeden Island pottery types, however, implies Wakulla Check Stamped vessels to be, like Lake Jackson Plain, holdovers from Fort Walton. Indians from this area, attracted to Spanish missions near Tallahassee, may have been the ones who made Leon Check Stamped pottery found at the San Francisco de Oconee mission. A few of the Jefferson Ware sherds from that mission have a whitish surface color. They may also indicate a similar connection.

Two tests, each 5 by 10 feet, were dug to learn what types of pottery might be found below the base of cultivation. Swift Creek Complicated Stamped, Deptford Simple Stamped, many Plain, sand-tempered, and two Plain, Fort Walton paste sherds were uncovered below the plow line. These tests substantiate implications from the surface collection that this site had a Santa Rosa–Swift Creek occupation prior to Leon–Jefferson times.

It may also be suggested that two periods are represented by stone objects from this site. No doubt the small, narrow triangular

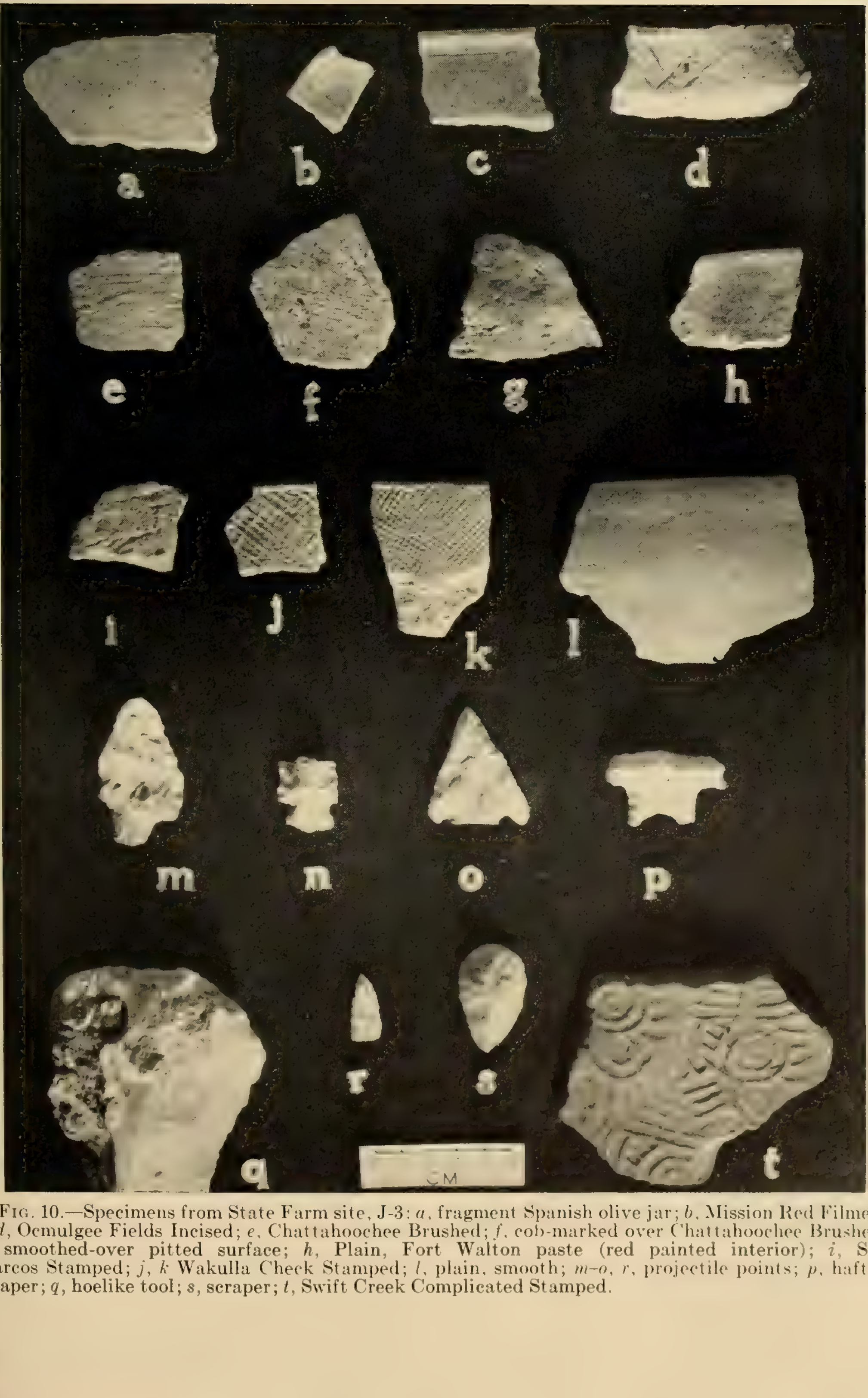

Fig. 10.—Specimens from State Farm site, J-3: *a*, fragment Spanish olive jar; *b*, Mission Red Filmed; *c*, *d*, Ocmulgee Fields Incised; *e*, Chattahoochee Brushed; *f*, cob-marked over Chattahoochee Brushed; *g*, smoothed-over pitted surface; *h*, Plain, Fort Walton paste (red painted interior); *i*, San Marcos Stamped; *j*, *k* Wakulla Check Stamped; *l*, plain, smooth; *m–o*, *r*, projectile points; *p*, hafted scraper; *q*, hoelike tool; *s*, scraper; *t*, Swift Creek Complicated Stamped.

arrow point (Fig. 10, *r*) is late; the others earlier.

Lower Creek(?) Sites

Ten sites, located on uplands, have been designated Lower Creek (?). This does not imply that any of them *necessarily* represent historic Creek villages. All are characterized by a high percentage of Chattahoochee Brushed. In common with the State Farm site (J-3) they produced many "white-slipped" sherds. Of post-Weeden Island sherds from these sites, 35 percent exhibit this color. In contrast with Fort Walton, extremely few sherds (including those listed as Plain, Fort Walton paste) contained mica.

No doubt some of these sites were contemporaneous with the Leon-Jefferson period to the south. Early nineteenth-century English stoneware at many of them suggests the possibility that some may have existed late enough to secure such utensils from traders or early settlers.

At all ten sites material, listed in Table 3, was collected from cultivated fields. In no case did tests disclose Indian material below the zone of cultivation. It is obvious from the inventories that more than one period is represented at several of these sites.

Three sites J-28, J-29, and J-30, all at Port Jackson[8] may be considered as a unit and may actually be parts of the same site. They are located on land inhabited by Econchatimico, an Indian chief, and his people around 1823. The tool listed for J-28 is a keeled end and side scraper, 3 inches long.

A settlement at this location is included in a list of Seminole towns in 1821 as follows (Swanton, 1922, p. 407):

> Tock-to-eth-la, west of Fort Scott and Chattahouchy, ten miles above the fork; forty or fifty warriors were raised at the O-cun-cha-ta, or Red Ground, and moved down.

This town is given again in a list dated 1823 (ibid., p. 411):

> (Town) Totoawathla, (Chief) Eheconhatamico, (Situation) west side of Chattahoochee, 10 miles above the forks.

Following the river, Port Jackson is 9½ miles northwest of the Forks.

In an additional article to the Treaty of Moultrie Creek, signed September 18, 1823, certain chiefs were allowed to maintain their establishments even though they were not located on land assigned by the treaty to Indian use. Econchatimico's land was set off as follows:

> For Econchatimico, a reservation commencing on the Chattahoochee, one mile below Econchatimico's house, thence up said river four miles, thence one mile west, thence southerly to a point one mile west of the beginning, thence east to the beginning point.

The article closes with "the number of men retained by the chiefs who have reservations made them at their respective villages." In the list Econchatimico claimed 38 men (Williams, 1837, pp. 282–286).

Econchatimico's land is shown on an Indian Land Cession map to have extended northward from a little below Butler (Royce, 1899, map 14, insert 185). W. S. Pope, Sr., of Sneads, 86 years old in 1949, advised the writer that his grandfather, William S. Pope, the first settler of Sneads, arrived there in 1823 and entertained Econchatimico at dinner on various occasions. Mr. Pope and his sister, while not certain, think Econchatimico's house was at Port Jackson.

At Port Jackson high land near the river is rather large in area and the soil a good sandy loam. It would seem to be the most likely location in the vicinity and I am inclined to believe Econchatimico's home was at Port Jackson as suggested by Mr. Pope.

We do not know when Econchatimico moved to this area but history gives us a clue. In the spring of 1818, McIntosh with a force of Creeks marched down the west bank of the Chattahoochee. On the way they surprised the Indian village of Hitchetaw (in Alabama) "commanded by the Redground King, Econchatti Mico." He escaped but 56 men, 180 women and children, and a quantity of cattle were taken (Williams, 1837, p. 180). On March 10, 1836, Econchatimico was raided again, this time at Port Jackson and by whites, and 20 of his slaves, valued at $12,000–15,000, were stolen (*ibid.*, p. 273; Brevard, 1924, pp. 278–279; House Document 271, pp. 24–39). De Castelnau (1948, p. 205) mentions Econchatimico, then a very old man, in 1838.

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[8] Not to be confused with Lake Jackson, which is near Tallahassee.

Sherds from the three sites at Port Jackson may represent Econchatimico's village, known to have been in existence from about 1819 to 1838. This is the period of the great popularity of Staffordshire stoneware when vast quantities were exported from England to the United States. This stoneware at Fort Jackson and other Lower Creek(?) sites *may* also have been in use this late. Indians were commonly making pottery in 1778, only 45 years earlier, when Bartram passed near here (Van Doren, 1940, pp. 342, 399, 401).

On the other hand, this area was well peopled by whites and many boats took produce up and down the Chattahoochee and Apalachicola Rivers by 1838 (de Castelnau,

Table 3.—Material from 10 Lower Creek(?) Sites

Specimens	J-28	J-29	J-30	J-42	J-43	J-46	J-47	J-48	J-49	J-50
Chert:										
Chips	23	2	114	96+	6	69+	28+	32+	33+	41+
Cores	1		2	1			1	1	1	1
Utilized flakes	1		1	5		1	1	2	2	8
Worked fragments				6		4		2	3	5
Tools, see text	1			12		3		2	7	7
Quartz:										
Fragments of pebbles				6	1	2	1			1
Hammerstones				2						
Sandstone:										
Rough slab				1						
Shells:										
Oyster				1						2
Busycon				1						
Pottery:										
Chattahoochee Brushed	4	21(2)	3(2)	33(30)	11(9)	31(22)	25(9)	5(2)	16(10)	16(7)
Alachua Cob Marked	1							1		
Miller Plain	1	2								
Leon Check Stamped				2						
Ocmulgee Fields Incised					1	1				
Fort Walton Incised				3(1)						
Plain, Fort Walton paste	7(1)	11(3)	2	66(21)	25(7)	36(10)	22(8)	25(5)	21	22(11)
Notched rims, Fort Walton paste						3	2(2)			
Miscellaneous:										
Plain smooth		9				4			7	
Stamped	7									
Incised				1	2	1		1	1(1)	
Roughened surface				1	1				2	
Handle				1				1		
Wakulla Check Stamped				7				23		
Weeden Island Plain								2		
Weeden Island Red								1		
Smooth Plain								10		
Swift Creek Complicated Stamped						8				1
Crooked River Complicated Stamped				1						
West Florida Cord Marked				2			1			1
Gulf Check Stamped				11		4	2			1
Deptford Simple Stamped				3		1				
Deptford Bold Check Stamped (tetrapod)				1						
Deptford Lineal Check Stamped				5						
Combination ditto and incised lines				2						
Indistinct stamped				13					1	
Plain, sand-tempered				16		21	3	52	7	10
Plain, fiber-tempered				1						
Total Sherds	20	43	5	169	40	110	55	121	55	51
English stoneware, early nineteenth century	4	5	1	40	1		2	3	3	

1948, p. 208). This English stoneware may, therefore, have belonged to early settlers. If so, they only broke the more common types (blue-edged plates, etc.). Sherds from "collector's items" or from the middle of the nineteenth century were not found.

Specimens from J-42 are illustrated in Fig. 11. This site was probably occupied earlier than any other located by the survey. It is the only one at which a fiber-tempered sherd or any appreciable amount of Deptford pottery was found. It was occupied from Deptford into early Santa Rosa–Swift Creek as well as in Lower Creek(?) times. Leon Check Stamped sherds indicate communication during the latter occupation with Leon-Jefferson—Spanish Mission people to the south. Sherds of Fort Walton Incised are, presumedly, coeval or slightly earlier in date.

Close agreement between pottery of the Lower Creek(?) component of this site with that secured at Port Jackson is evident from the foregoing tabulation. Horizontal distribution of English stoneware agreed with that of Indian pottery. Chips and stone specimens covered a larger area.

Stone specimens, believed to belong to a Deptford occupation, include seven large stemmed points, one small and two large end scrapers, all of chert, a stone disk or pitted hammerstone of quartzite (Fig. 11, *m–u*, respectively) and a rough slab of limestone. One of the projectile points, after being broken, was reworked into a scraper (Fig. 11, *r*).

The inventory from J-43 agrees well with that from the sites at Port Jackson. It should be noticed that neither stone specimens nor early pottery was found.

J-46 had a previous Santa Rosa–Swift Creek occupation. All 24 sherds from that period are eroded while those of the Lower Creek (?) period are not eroded. Stone specimens include a patinated, rough, thick, trianguloid blade; part of an unpatinated, long, trianguloid point with concave base; and a chipped hoelike implement.

A few Santa Rosa–Swift Creek sherds were found at J-47 site. Again the early sherds are eroded, the late ones are not.

The earlier occupation at J-48 was late Weeden Island instead of Santa Rosa–Swift Creek. The two stone tools listed in Table 3 consist of a large stemmed knife and a triangular projectile point. The latter is similar in shape but half again as large as the triangular point from the Butler site (Fig. 5, *z*).

Evidence of a second occupation other than Lower Creek(?) was found at J-49 but, unfortunately, the older sherds are not definitive. Lithic specimens include a chipping hammer, a rough thick asymmetric trianguloid blade, a lanceolate-shaped knife, and four thick stemmed projectile points. The latter have fine retouching along the sides of blades. One, having lost its tip, was reworked into a scraper.

Santa Rosa–Swift Creek is suggested for the earlier habitation at J-50 by the meager inventory of that period available. As before, the Lower Creek(?) period is evidenced by Chattahoochee Brushed and "white slipped" pottery.

Seven stone specimens include three large stemmed projectile points, of which one has been reworked into a scraper. One long and two medium sized projectile points with side notches similar to those from the Tan Vat site (Fig. 4, *q*) were found. A triangular arrow point, duplicating the similarly shaped one from the Butler site (Fig. 5, *z*), completes the lithic inventory.

CONCLUSIONS

We have no information pertaining to man in the lower Chattahoochee Valley prior to Deptford times, circa A. D. 500. This period is represented by an appreciable number of sherds at only one site (J-42). Generalizations concerning life during a Deptford period do not seem warranted.

For Santa Rosa–Swift Creek we have much more data. Six sites or components of that period are located, as will be noted from the map, either on bottom land removed from the present river channel or on high ridges near small streams or the river. Twelve components of the succeeding Weeden Island horizon are similarly located. The Chattahoochee has undoubtedly run in various channels. Bottomland sites may have been adjacent to the river when inhabited.

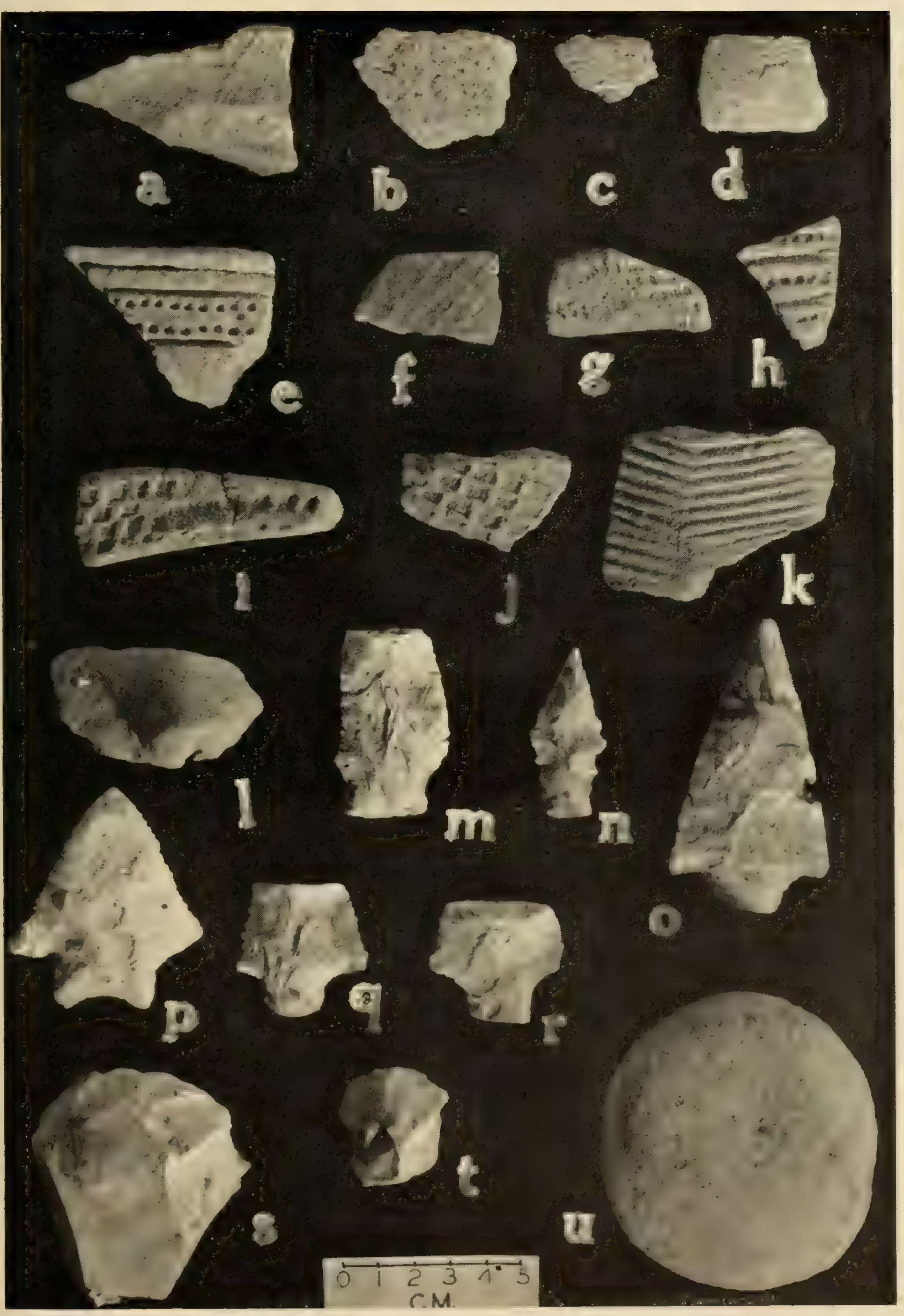

FIG. 11.—Specimens from Neal site, J-42: *a*, Leon Check Stamped; *b–d*, Chattahoochee Brushed; *e*, Fort Walton Incised; *f*, Wakulla Check Stamped; *g*, West Florida Cord Marked; *h*, combination Deptford Linear Check Stamped and incised; *i*, Deptford Linear Check Stamped; *j*, Gulf Check Stamped; *k*, Deptford Simple Stamped; *l*, Deptford Bold Check Stamped on tetrapod; *m–q*, projectile points; *r*, hafted scraper made from broken point; *s*, *t*, scrapers; *u*, hammerstone, slightly pitted.

The relatively large number of stone specimens from these sites shows a major dependence on hunting but does not indicate a lack of agriculture. In Weeden Island times fresh water shellfish and snails were collected to supplement other food. Sites are small and have a general north-south distribution. This fits a picture of small villages of hunters and collectors of food who were developing into farmers.

Changes in hunting techniques are suggested by changes in projectile points. Deptford and early Santa Rosa–Swift Creek hunters used fairly large and thick stemmed points which frequently had serrated edges. These were probably hafted on spears and propelled by atlatls or spear-throwers. In the latter part of the Santa Rosa–Swift Creek period some points, as evidenced by those from the Tan Vat site (J-18), were smaller and side-notched. These and broad points with deep corner notches, here tentatively correlated with Weeden Island I (site J-31), may have been used with either atlatl or bow and arrow. By Weeden Island II the bow and arrow were well known. Points from the Butler site (J-17) of this period indicate various methods of attachment but are all small in size. Very likely older forms were used contemporaneously with newer ones during these periods.

A distinct cultural shift occurs with the Fort Walton period. Sites (nine) are exclusively located along the present riverbank. Stone tools were of very minor importance and ceramic arts substantially modified. While venison was still enjoyed and shellfish occasionally collected, agriculture had become the basis of the economy. Rich, sand-silt, flood plains attracted people away from the relatively poor farm land of the uplands. At Chattahoochee Landing large flat-topped mounds were constructed as foundations for buildings. Although not demonstrable for the lower Chattahoochee, narrow triangular arrow points are known to have been in use elsewhere during this period.

Farming communities, scattered along river banks and radiating out from a civic and ceremonial center at Chattahoochee Landing, probably formed the social organization of that time.

These radical changes are believed to be the result of influences and people expanding from the Mississippi Valley. The presence in large quantities of Wakulla Check Stamped pottery, typical of the preceding period, indicates that the population of the valley was not entirely displaced by new people.

Another geographical shift occurs with the end of Fort Walton. Presence of Chattahoochee Brushed and Alachua Cob Marked pottery at the Jim Woodruff (J-2) and at J-23 sites, both of the Fort Walton period, demonstrate them not to have been abandoned before the impact of new influences from outside the lower Chattahoochee Valley. These influences may have had a more impelling force than floods in causing abandonment of levee sites.

Along the Gulf coast about half of the Fort Walton sites have produced articles of European manufacture. For this reason end of Fort Walton has been arbitrarily set as circa 1650. This date is merely an estimate and might be as much as 50 or more years off, either way. It is also quite possible that people continued living with a Fort Walton culture later in the lower Chattahoochee Valley than they did on the Gulf coast.

Spanish missions, at which there were domesticated animals, were started across north Florida in 1633 and virtually wiped out by Governor Moore of South Carolina in 1704 (Boyd, 1939, p. 255). Adair says horses and hogs were common in Indian towns to the north of Chattahoochee in 1740–1760 (Williams, 1930, pp. 290, 390, 436, 444). Bartram's Travels contain many references to Indians having horses, cattle, hogs, and Negro slaves in 1777 (Van Doren, 1940, pp. 350–351). In 1718 Indians living near St. Augustine and St. Marks had horses, cattle, and hogs (Williams, 1837, p. 180).

The end of Fort Walton times is not too far removed from dates when Indians are known to have had domesticated animals. Need of more area to exploit this new source of food and a lessened dependence on *rich* farmland may have resulted in the abandonment of Fort Walton sites along the lower Chattahoochee. Concomitant deterioration in ceramic arts would reflect the prestige value of livestock and the attention given to them.

Post-Fort Walton sites in the lower Chattahoochee Valley fall into two groups. Leon-

Jefferson sites, near Sneads, are oriented, at least in their ceramics, toward the Spanish missions around Tallahassee to the southeast. The other group, consisting of nine Lower Creek(?) sites, are characterized by Chattahoochee Brushed pottery, which is common in this period in eastern Alabama and western Georgia. They are oriented toward the north. Trade sherds prove these two areal divisions to be in part contemporaneous.

One is tempted to see in these Lower Creek(?) sites evidence of the southern drift of Indians, part of whom, together with other groups, later became Seminoles. Bartram, who crossed the middle Chattahoochee River (in Alabama) in 1777, mentions the Creek town of Apalachula and notes that *old* Apalachula had been abandoned about twenty years before. The greater number from there, he writes, chose to settle new (1777) Apalachula but other bands under auspices of the chief of each family or tribe settled villages lower down the river (Van Doren, 1940, p. 314). The archeological evidence fits well with Bartram's information.

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ENTOMOLOGY.—*A new genus and species of trombiculid mite (Acarina).*[1] ROBERT TRAUB, Major, MSC, and THOMAS M. EVANS, Army Medical Department Research and Graduate School, Washington, D. C. (Communicated by ALAN STONE.)

Among the trombiculid mites collected by the United States of America Typhus Commission in Assam and Burma in 1944–45 is a remarkable new genus of the subfamily Trombiculinae Ewing, collected from a bird.

Mackiena, n. gen.

Agrees with *Riedlinia* Oudemans 1914 in that middle claw is represented by a swollen empodium—the only trombiculid mites in which this condition is known to occur. Separated from *Riedlinia* in that the empodium is pulvilliform, not lanceolate or spatulate; in that the eyes are well developed, not absent; in that the dorsum and venter are covered with a series of fine, definite, concentric circular striations resembling whorls of fingerprints; the palpal claw is trifurcate, not bifurcate; segment II of palpus lacks a lateral tubercle and is devoid of setae (*Riedlinia* bears both a lateral tubercle and a seta); the palpal genu bears a frayed seta, not a nude one; the galea seta is plumed, not nude.

Agrees with *Euschöngastia* Ewing 1938, in that the scutum or dorsal plate bears a single anteromedian bristle, a pair of posterolateral bristles, a pair of anterolateral bristles, and the sensillae are clavate-globose; the chelicerae nonserrate, with a single subapical notch.

With an indication of a crest immediately anterior to the bases of the pseudostigmatic organs. Anterior portion of dorsal plate finely punctate; caudal portion distinctly whorled, with concentric striations. Coxae unisetose. With four ventral setae between coxae III.

Genotype: *Mackiena empodiformia*, n. sp.; no other species known.

Mackiena empodiformia, n. sp.

Larval description (Figs. 1–4).—Body: Outline ovate-subcircular, slightly angulate laterally between coxae II and III; dorsum and venter covered with well developed, concentric circular striations in the form of whorls like fingerprints or contour lines on a map; length 0.23 mm, width 0.185 mm. Dorsal plate: Anterior margin slightly sinuate, with one median and two lateral lobes; lateral margins evenly rounded, convex; ratio of length to width: 9 to 13; punctate over most of surface, especially anterior portion, but punctations extending into whorled area; whorls extending cephalad to bases of sensillae (pseudostigmatic organs); with a darkened sinuate ridge extending anterior to and mesad of bases of sensillae, the sinus deepest mesad of bases. Sensillae clavate-globose, petiole extremely short; tomentose; distal fourth of pseudostigmatic organ extending beyond posterior margin of dorsal plate. Bases of pseudostigmatic organs inserted on a line minutely cephalad of bases of posterolateral setae. Anterolateral setae long and narrow; slightly more than twice the length of dorsal plate; plumose but with short cilia. Anteromedian bristle same diameter as anterolateral, but only slightly longer than dorsal plate; inserted in line with anterolaterals; plumose but with short cilia. Posterolateral setae inserted at level of midline of dorsal plate; similar to anterolaterals but only three-fourths the length. Eyes: Well developed; contiguous to dorsal plate laterad of bases of dorsolateral setae; cephalic eye with slightly greater diameter than caudal eye; combined length 24.5μ; width of cephalic eye 12μ. Chelicerae: Acuminate, about 5 times as long as wide near base; with a single subapical notch on each side. Palpal claw: Trifurcate, lateral prongs about three-fourths length of middle prong. Palpal tarsus: Almost twice as long as broad at base; with two dorsal branched setae, an apical smooth seta, two ventral plumed setae and a proximal ventral short spurlike process. Palpus: With a proximal dorsal plumed seta on palpal trochanter and femur; with a dorsal, sparsely frayed seta on genu; 1 fine seta on dorsal surface and 1 frayed and 1 entire smaller bristle on ventral surface of tibia. Galea: With a pair of plumed proximal ventral setae. Dorsal setae: Similar to dorsolaterals, about 30 in number, with rows arranged 2-6-4-6-(?). Coxae: Unisetose, setae plumose; coxa I with a dorsal thumblike extension at caudolateral angle, dorsad to well-developed stigma. Sternal setae: A pair of plumose setae between bases of coxae I and

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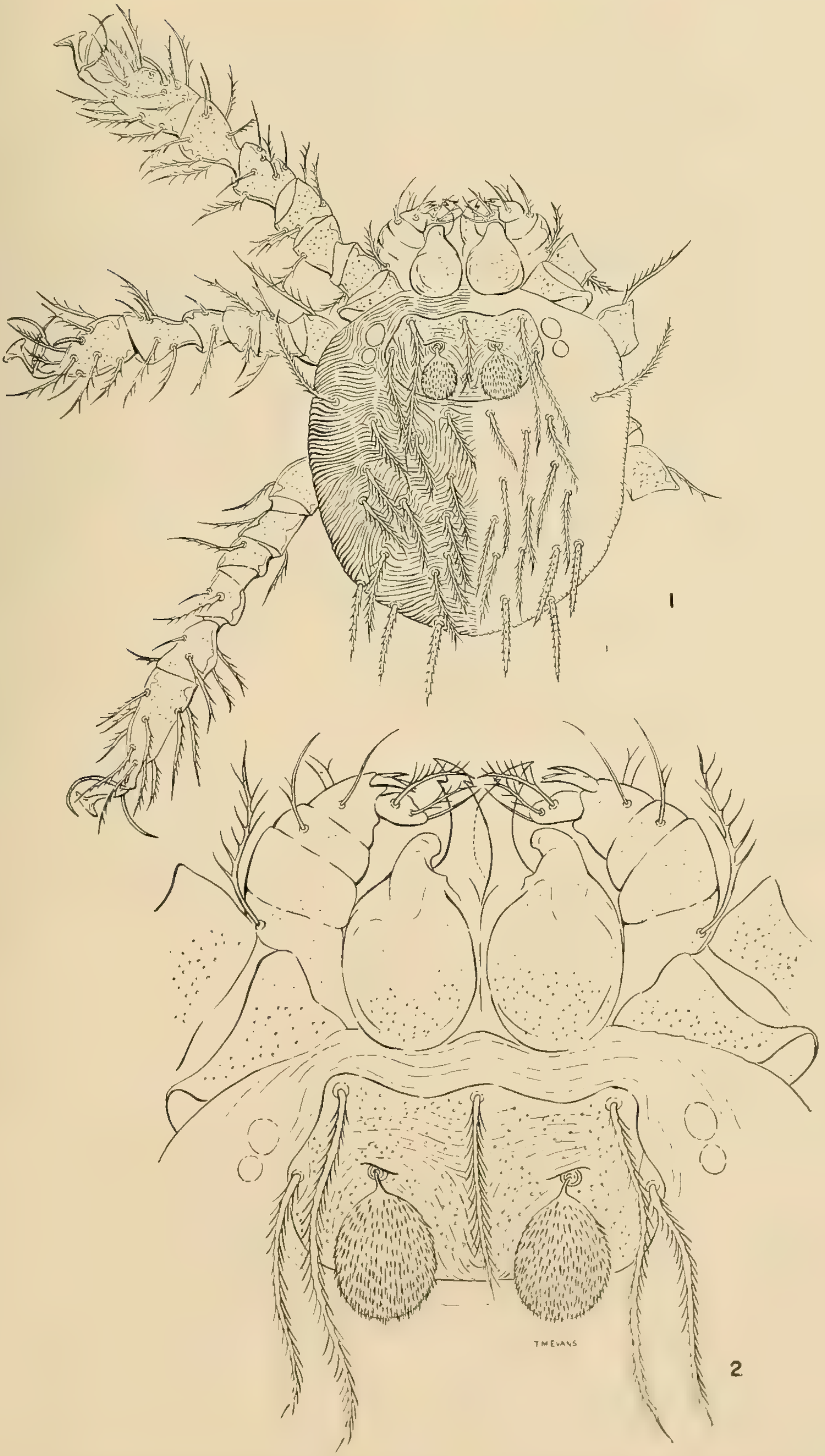
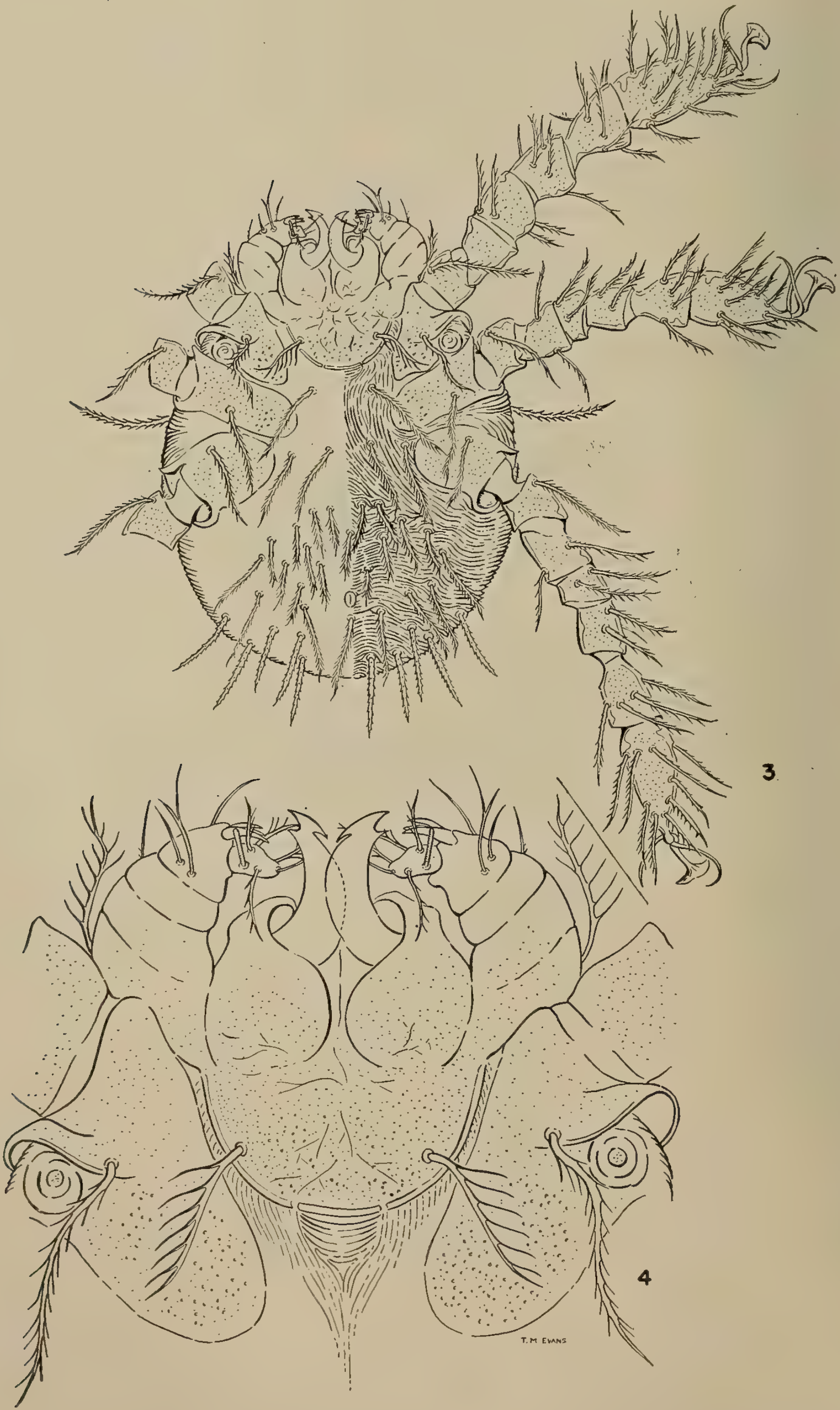
[1] Published under the auspices of the Surgeon General, U. S. Army, who does not necessarily assume responsibility for the professional opinions expressed by the authors. Received December 22, 1949.



FIGS. 1, 2.—*Mackiena empodiformia*, n. gen. and sp.: 1, Dorsal aspect of larva; 2, details of anterior region.



Figs. 3, 4.—*Mackiena empodiformia*, n. gen. and sp.: 3, Ventral aspect; 4, details of anterior region.

II, and two similar pair between coxae III. Ventral setae: About 36 thin frayed setae in horseshoe shaped rows of 10-8-8-(?), the sinus of each row facing caudad; the more posterior setae somewhat longer and stouter than more anterior. Legs: I—0.26 mm; II—0.25 mm; III—0.27 mm. Sensory setae as follows: I—1 spur, 2 genualae, 1 microtibiala, 1 subterminala, 1 microspur, 1 microgenuala, 2 tibialae. II—1 spur, 1 genuala, 2 tibialae. III—1 genuala and 1 tibiala. Tarsal claws: Outer claws elongate, acuminate, curved, resembling the blade of a scythe; proximal portion of empodium subequal to diameter of claw, expanded portion of empodium about 4–5 times diameter of claw.

Type material.—Holotype (U. S. A. Typhus Commission no. 718-1) deposited in U. S. National Museum. One paratype in collection of British Museum of Natural History.

Records.—Holotype and paratype from a weaver-finch (*Ploceus manyar peguensis* Stuart Baker); 20 miles northwest of Myitkyina, on Mogaung Road, February 23, 1945, collected by United States of America Typhus Commission.

Remarks.—The genus is named for Col. T. T. Mackie, M.C., who was in command of the India-Burma Field Party of the United States of America Typhus Commission. Capt. Roy T. Melvin of that organization first recognized the generic status. I am deeply indebted to Dr. H. S. Fuller, of the Harvard School of Public Health, who examined *Riedlinia coeca* in the Oudemans collection and who kindly allowed me to use his notes concerning this species. Dr. G. W. Wharton, of the Department of Zoology, Duke University, was instrumental in transmitting Dr. Fuller's notes to me.

STANDARD MEASUREMENTS

Slide No.	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	SENS	DS
718-1 (holotype)	56	76	37	21	21	19	46	84	66	30	56
718-2 (paratype)	57	78	38	—	—	—	42	84	67	—	63
Mean	56	77	38	21	21	19	44	84	67	30	60

ZOOLOGY.—*A new copepod,* Pseudanthessius latus *(Cyclopoida: Lichomolgidae), commensal with a marine flatworm.*[1] Paul L. Illg, U. S. National Museum (Communicated by Fenner A. Chace, Jr.)

For some years there has been on record the existence of a copepod ectocommensal of very large marine flatworms found on the Pacific coast of the United States. Identified by Wilson, 1935, as *Pseudanthessius obscurus* Scott, several specimens have been preserved in the National Museum. Since that date additional specimens have been added to the collection by the original collectors, Mr. and Mrs. G. E. MacGinitie. Other specimens have been seen and collected from Puget Sound by the author and by Dr. Frank A. Pitelka. Detailed study of the specimens available demonstrates them to represent a new species, well differentiated from the remaining members of the genus. Nicholls, 1944, provided a key to the species known to that date and pointed out the necessity for exclusion of some incorrectly assigned species. Since this treatment there has appeared the descriptions of 2 new species, *P. gracilioides* Seymour Sewell, 1949, and *P. spinifer* Lindberg, 1946. Accordingly, Nicholls's key, with modification to provide for the 3 subsequently found species, is presented below as a concise differentiation of the various forms.

Family Lichomolgidae Claus, 1889

Pseudanthessius Claus, 1889; Nicholls, 1944

The genus is very close to *Lichomolgus.* The salient differentiating character is the reduced fifth foot, consisting of only a spine and two setae, originating directly from the body proper, all other vestige of the appendage as free outgrowth having been completely suppressed.

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received December 2, 1949.

KEY TO SPECIES OF PSEUDANTHESSIUS

[Modified after Nicholls, 1944]

1. Outer margin of fourth endopodite entire, simply convex..........................2
   Outer margin of fourth endopodite sinuate, broken by a swelling or indentation which may become a conspicuous knob or notch...4
2. Lateral margins of genital segment produced into conspicuous expansions *spinifer* Lindberg, 1946
   Lateral margins of genital segment not conspicuously expanded.....................3
3. Caudal rami twice as long as wide, little longer than anal segment *liber* (Brady and Robertson, 1875)
   Caudal rami three times as long as wide, one-third as long again as anal segment *assimilis* Sars, 1917
4. Greatest width of fourth endopodite over one-half length..................*latus*, n. sp.
   Greatest width of fourth endopodite less than one-half length..........................5
5. Caudal rami twice as long as wide *sauvagei* Canu, 1891
   Caudal rami more than twice but not more than four times as long as wide.......6
   Caudal rami more than four times but not more than seven times as long as wide.......8
   Caudal rami at least 10 times as long as wide 9
6. Fourth endopodite with marked notch at proximal third; segments of first antenna short and compact; genital segment not greatly dilated......*obscurus* A. Scott, 1909
   Fourth endopodite with notch or constriction at center; segments of first antenna normal; genital segment considerably dilated.......7
7. Second thoracic segment with posterior projections; fourth endopodite no longer than basal segment of exopodite, with proximal bulge but no notch. *mucronatus* Gurney, 1927
   Second thoracic segment without posterior projections; fourth endopodite longer than basal segment of exopod and with a distinct notch................*tenuis* Nicholls, 1944
8. Fourth endopodite with marked notch at about center; less than four times as long as wide..................*gracilis* Claus, 1889
   Fourth endopodite with notch at center; more than five times as long as wide *gracilioides* Sewell, 1949
   Fourth endopodite with slight notch at center and proximal bulge; caudal rami five times as long as wide......*weberi* A. Scott, 1909
   Fourth endopodite without notch but with slight proximal bulge; caudal rami four to four and one-half times as long as wide *nemertophilus* Gallien, 1935
9. Last two segments of urosome subequal.....10
   Anal segment at least twice as long as preanal *thorelli* (Brady and Robertson, 1875)
10. Caudal rami about as long as last two segments of urosome together......*dubius* Sars, 1918
    Caudal rami about as long as last three segments of urosome together *concinnus* Thompson and Scott, 1903

Pseudanthessius latus, n. sp.

Pseudanthessius obscurus C. B. Wilson, 1935, p. 780, pl. 27, fig. 36.

Specimens examined.—12 females, 8 males, all adult; Anaheim Slough, Calif.; surface of large gray flatworm; October 22, 1937; G. E. MacGinitie.

1 female; adult; San Juan Island, Wash.; surface of large flatworm; July, 1939; Paul L. Illg.

6 females, one male, all adult; Santa Ana River, Calif.; backs of large flatworms; December 11, 1932; G. E. MacGinitie. (Recorded as *P. obscurus* Scott, Wilson, 1935.)

9 females, adult; Turn Rock, near San Juan Island, Wash.; surface of large flatworms (*Cryptophallus magnus* Freeman); July 2, 1940; F. A. Pitelka.

Types.—Holotypic female, U.S.N.M. no. 90285; allotypic male no. 90286; locality Anaheim Slough, Calif.; scientific name of flatworm host not known. The remainder of the specimens examined are designated paratypes.

Description.—Female (Figs. 1, *a–k*): Body length 1.82 mm. Body form (Fig. 1, *a*) typically lichomolgid but with conspicuous broadening of the metasome, producing an anterior body region of suborbicular outline. There is no rostrum. The thoracic segment bearing the first swimming legs is fused into the cephalothoracic portion of the metasome. The segments of the second to fourth swimming legs are free, that of the second legs much the widest, that of the third legs longer than the others. The segment of the fifth legs is sharply set off both from the metasome and the genital segment. The urosome, including the segment of the fifth legs, is 5-segmented. The genital segment is much dilated anteriorly, thus being considerably wider than long. The three free abdominal segments are subequal in length, each slightly longer than wide. The caudal rami are at least $1\frac{1}{2}$ times as long as the anal segment. The longest seta of each caudal ramus is longer than the combined lengths of the free abdominal segments and rami. The ovisacs are elongate, slender cylinders, carried closely appressed to the abdomen, and, in most cases, slightly exceeding the tips of the caudal rami. The eggs are minute and a rough estimate would indicate there are upwards of 300 eggs in each ovisac. The general body aspect is neat and trim and the proportions achieve a fairly graceful symmetry.

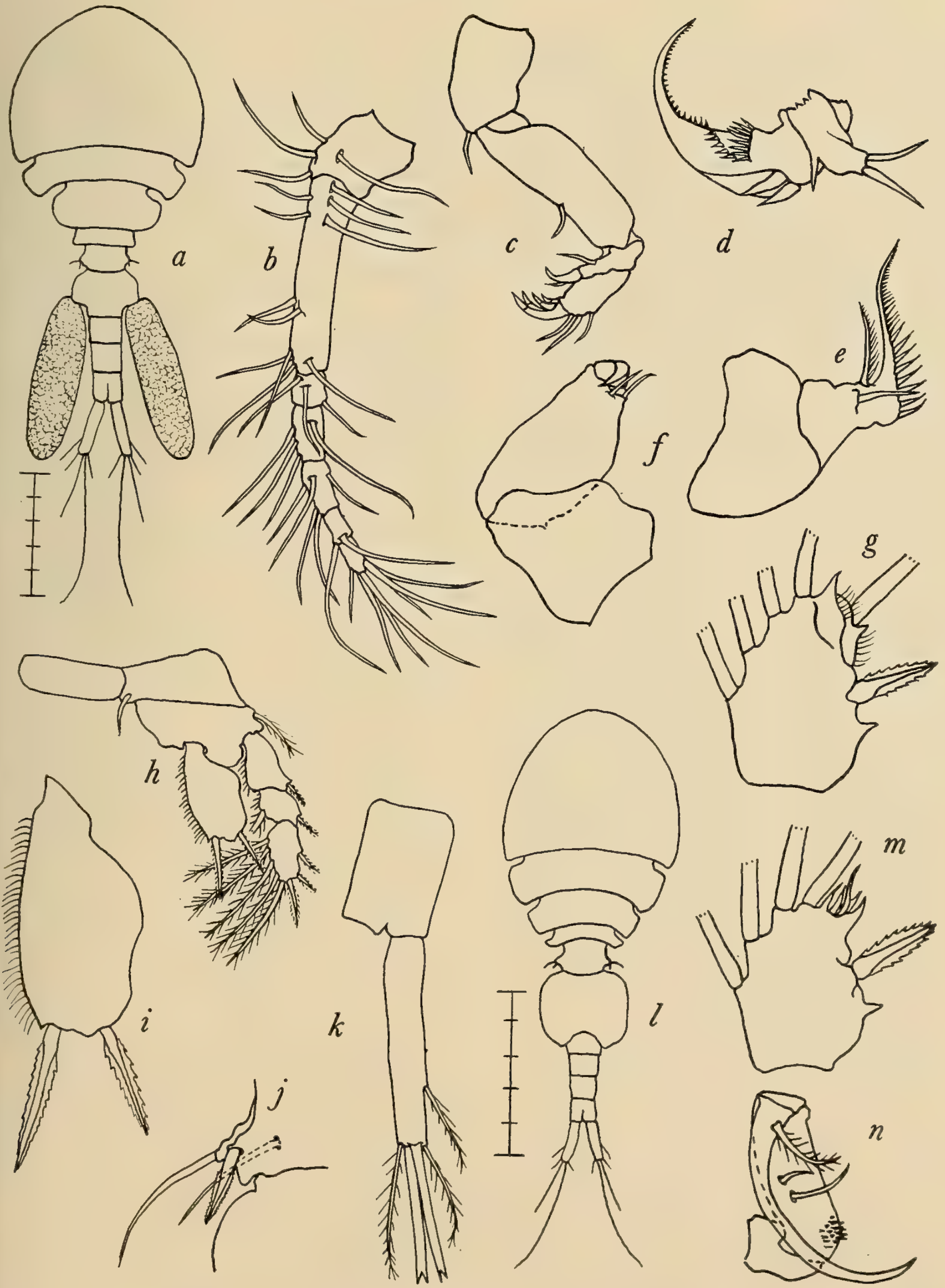

FIG. 1.—*Pseudanthessius latus*, n. sp. Female: *a*, Dorsal view; *b*, antennule; *c*, antenna; *d*, mandible and maxillule in posterior view so that maxillule appears as superimposed upon mandible; *e*, maxilla; *f*, maxilliped; *g*, distal segment of first endopodite; *h*, fourth swimming leg; *i*, fourth endopodite; *j*, fifth leg; *k*, caudal ramus. Male: *l*, Dorsal view; *m*, terminal segment of first endopodite; *n*, maxilliped. The scales referring to dorsal views of male and female represent 0.5 mm.

Antennule (Fig. 1, *b*) rather elongate, of the usual seven segments. The relative proportions of the segments are distinctive. The elongate second segment exceeds the combined lengths of the five terminal segments and provides a character by which the species may be readily identified. The setation is represented in the figure. The antenna (Fig. 1, *c*) is the usual 4-segmented prehensile appendage. There is a single seta borne terminally on the basal segment. The second segment bears a single subterminal seta. The third segment has a diagonal articulation with the fourth segment and is produced considerably along the medial margin of the terminal segment. At the apex of the produced portion is set a prehensile claw, accompanied by two slender, short setae. The fourth segment is somewhat longer than broad. On its distal margin there is a closely set group of four subequal, lineally graduated, jointed claws, accompanied by three slender setae. None of the setae or claws is as long as the segment.

The mandible (Fig. 1, *d*) is the usual flat blade, produced into an elongate, tapering tip. Its distinctive ornamentation consists of two broad, chitinized flaps basally on the outer margin, and a row of spinules which are set along the inner curve from the tip to about midway on the length of the blade. Here the spines become long and stout and are set across the posterior surface of the mandible along two sides of a triangular outline. The base of the mandible is closely associated with the base of the maxillule (Fig. 1, *d*). The maxillule is a thin flap, its margin incised deeply medially to produce a long spiniform process. Terminally the flap narrows to a short, truncate apex on which is borne two relatively long subequal setae.

The maxilla (Fig. 1, *e*) is not particularly distinctive, conforming to that found in a number of lichomolgids. It is 2-segmented. The terminal segment tapers to a long, perpendicularly bent lash. This bears along its margin, medial in normal orientation on the animal, a regular row of elongate spinules, these diminishing in length and stoutness apically. There are two accessory setae on the base of this terminal segment. The shorter, which is unornamented, lies appressed to the surface of the basal portion of the second segment and parallel to the long axis of the basal portion. The second bears a single row of cilia along its medial margin and is set on the anterior edge of the basal part of the segment so that it extends parallel with the lashlike distal extension of the segment.

The maxilliped (Fig. 1, *f*) is very stout. There are two subequal proximal segments. Articulated on the apex of the second segment is a pronouncedly tapered, much reflexed claw. This may be a third segment or simply an articulated spine. It is provided with an extensive musculature. Accompanying the articulated spine are two short, slender setae, borne apically on the second segment.

The arrangement of the spines and setae on the four pairs of legs follows. The count of spines is presented in Roman numerals, that of the setae in Arabic. The segments of each ramus are designated in order from the basal segment distally. First exopodite I-0; I-1; IV-4; endopodite O-1; O-1; I-5. Second exopodite I-0; I-1; IV-5; endopodite O-1; O-2; III-3. Third exopodite I-0; I-1; IV-5; endopodite O-1; O-2; III-2. Fourth exopodite I-0; I-1; III-5; endopodite 1-segmented, with two terminal spines.

The endopodite of the fourth leg (Fig. 1, *h*) is distinctive in its considerable inflation of outline. From a basal articulation of proportions equivalent to those in the other endopodites it flares in a steep curve to a width nearly 2½ times that of the articulating margin, then diminishes along a sigmoid curve to a truncate apex which is still of relatively broad amplitude. There is no indentation of the integument of the lateral margin. The medial margin is finely ciliate. Distally there are borne two well-separated spines, of subequal dimensions. The medial spine is slightly longer than the other.

The fifth leg (Fig. 1, *j*) is reduced to a spine and two setae which originate directly from the lateral margin of the thoracic somite, as a result of complete suppression of the segments of the appendage. The spine is ventral and directed posteriorly. One seta is lateral, the other on the dorsal side; both are directed mainly laterally, but curve gently posteriorly. The caudal rami (Fig. 1, *k*) are long and slender, between five and six times as long as wide, somewhat divergent posteriorly. Each bears the usual complement of a short lateral plumose seta and four terminal plumose setae.

Male (Fig. 1, *l*): body length 1.55 mm. Metasome much slenderer than in the female, but of corresponding segmentation. The somite of the fifth swimming legs is more elongate than that of the female but equally markedly delimited from the adjoining segments. The urosome consists of six segments. The first abdominal segment is considerably enveloped anteriorly by the genital somite. The genital segment is laterally expanded to a subquadrate outline. The width exceeds the length. The four abdominal segments are subequal in length.

The appendages conform in the main to those of the female. The usual dimorphism characteristic of the lichomolgids is exhibited in the transformation of the maxilliped into a prehensile structure (Fig. 1, *n*), in the presence of sixth legs, and in the segmentation of the urosome. A further manifestation of dimorphism is seen in the alteration of the terminal segment of the first endopodite. In the female this segment bears a short lateral spine and five well-developed, plumose setae (Fig. 1, *g*). The male condition is the result of the suppression of the most lateral of the setae (Fig. 1, *m*). Here there are only four normally developed setae. The shape of the entire segment is altered somewhat and at the point which would normally support the fifth seta there are several spinose projections of the integument among which stands a short, slender wisp, which may represent an extreme reduction of the seta found in the female. A similar tendency to dimorphism in the swimming legs occurs in other lichomolgids and may offer a prospect of convenient specific differentiation in some cases.

Remarks.—The host of the present species, a marine polyclad (possibly more than one species), is an addition to the diverse roster of hosts of the genus. Previously recorded associates have been annelids, mollusks, echinoids, and a nemertean. Many of the records of the occurrence of species of the genus have been based on planktonic samplings. Continued free existence of these individuals would be most unlikely in view of the extreme specialization of the mouthparts which are unsuited to the capture of any motile organism and probably incapable even of seizure of free-floating particles. A varying degree of tenacity in adhering to the host on the part of these copepods must explain the relatively large number of species for which no host record has yet been established. In the present instance most specimens so far found have shown a marked inclination to adhere to the surface of the worm and many have so remained after hours of tumbling about in the diverse lot of materials obtained from several dredge hauls.

The specific differentiation of *Pseudanthessius latus* is readily established on characters consistent in both sexes. The fourth endopodite is highly distinctive, as is the elongation of the second antennular segment and both features are readily determinable under a low degree of microscopic magnification.

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MAMMALOGY.—*Notes on microtine rodents from the Brooks Range, Arctic Alaska.*[1]

Robert Rausch, U. S. Public Health Service, Anchorage, Alaska. (Communicated by David H. Johnson.)

In connection with parasitological studies carried on during 1949 for the U. S. Public Health Service, the writer collected a considerable number of mammals from the northern edge of the "Endicott" section of the Brooks Range, in Arctic Alaska. The mammalian fauna of this region is poorly known, since apparently no previous collecting has been done here. About 200 microtine rodents were collected, mostly near Tolugak Lake (lat. 68° 24′ N., long. 151° 26′ W.), near the head of the Anaktuvuk River Valley. A few specimens were also taken at Umiat, on the Colville River, about 80 miles north of Tolugak Lake (lat. 69° 23′ N., long. 152° 10′ W.). Five species are represented. More complete details concerning their ecology and reproduction will be presented in a later paper, at which time the other mammals obtained will also be considered. The specimens have been deposited in the U. S. National Museum.

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[1] Received January 18, 1950.

The writer wishes to express appreciation of the kind cooperation of Drs. Remington Kellogg, David H. Johnson, and Henry W. Setzer in making available working space and facilities at the U. S. National Museum, and of their helpful suggestions.

Clethrionomys rutilus dawsoni (Merriam)

Red-backed voles were collected at the northern edge of the Brooks Range, at altitudes from 2,000 to 3,500 feet, and at Umiat, at the edge of the Arctic Coastal Plain, at altitudes from 300 to 500 feet.

In connection with the identification of the species of Brooks Range *Clethrionomys*, it seemed advisable to study all available material in order to reach some conclusion as to the actual species involved. The rather extensive material from both Eurasia and North America in the collections of the U. S. National Museum was utilized in making this study, with the conclusion that the Nearctic *C. dawsoni* (Merriam) is conspecific with the Palearctic *C. rutilus* Pallas.

A series of more than 20 specimens of *Clethrinomys* was obtained near Tolugak Lake, and 5 others were collected at Umiat. In addition, 24 specimens from northern Alaska, in the U. S. National Museum collection, were compared in detail with Eurasian material. Of the latter, 92 specimens of *C. rutilus jochelsoni* Allen were studied, along with smaller series of *C. rutilus rutilus* Pallas, *C. rutilus russatus* Radde, and *C. rutilus hintoni* Vinogradov. The distribution of the Siberian species of *Clethrionomys* was shown by Bobrinskoy, Kuznetzov, and Kuzyakin (1944, map no. 55). *Clethrionomys r. jochelsoni*, decribed from Verkhne Kolymsk, Kolyma River, northeastern Siberia, is the form most closely related to that found in Alaska.

The Alaskan specimens were closely compared with the large series of *C. rutilus jochelsoni* and were found to be very similar. Cranially, the Alaskan material shows a slightly heavier and longer rostrum, although this character is somewhat variable in both series. The nasal bones are longer in the Alaskan material. Some of the Alaskan specimens show a slightly greater arching of the cranium than is seen in the Siberian specimens. The zygomata are variable in both series; some show an anterior narrowing, some a posterior narrowing, and in some the zygomatic width is the same throughout. The molar pattern, though somewhat variable, is very nearly identical in the two series. A summary of cranial measurements is given in Table 1.

Externally the Alaskan specimens from Tolugak Lake are hardly distinguishable from specimens from northern Siberia (Kolyma River). The Tolugak Lake specimens show a dark-rufous dorsal color, which becomes lighter and more tawny on the sides. The sides show a rather olive tinge during the spring and summer but become much more tawny and the dorsal color becomes brighter in the winter pelage, when fewer interspersed dark hairs are present. Ventrally the Alaskan specimens range from grayish to buffy. In winter pelage the tail is very hairy and is rufous above and buffy below. The specimens from Tolugak Lake and Umiat are considerably darker in color than those from farther south in Alaska (Chignik, on the Alaskan Peninsula, and Charlie Creek, near the Alaska-Yukon boundary). The specimens from the southern localities show a more yellowish cast throughout, and in dorsal coloration the Chignik specimens are indistinguishable from specimens of *C. r. jochelsoni* from the Lesser Annui River, Siberia. The latter are more yellowish below, however. Certain of the Siberian specimens of *C. r. jochelsoni*, from Nijni Kolimsk, show less dorsal rufous coloring.

A small series of specimens of *C. r. rutilus* from Tandy, oriental Siberia, is very similar to the northern Alaskan specimens, having also grayish underparts. Specimens from Lappmark, Sweden, show more tawny coloration, being very similar to the Alaskan specimens from Chignik. The animals from Dapucha, in the Altai, central Siberia, show a tendency toward grayness when compared with northern Siberian and with Alaskan specimens.

C. rutilus hintoni, from the Eimanachi River, Greater Kingham Mountains, northern Manchuria, shows a general paleness of color when compared with northern Siberian and Alaskan specimens. There is less tendency toward tawniness, and the underparts are whitish without any buffy tinge.

It has long been recognized that the north Alaskan species of *Clethrionomys* (*C. dawsoni* auct.) is very closely related to the Palearctic *C. rutilus*. Bailey (1897), speaking of the genus *Evotomys* (= *Clethrionomys*), stated: "The only circumpolar species is the Arctic *E. rutilus*, which does not undergo any considerable change throughout the circumference of the Arctic Zone," and further, that "boreal species are far more stable and persistent than those inhabiting warmer countries. In view of this fact, it is not surprising that the circumpolar *E. rutilus* presents but one phase throughout its entire range (specimens from Scandinavia, Siberia, and Arctic America being practically indistinguishable)." Zimmermann (1942), in regard to *C. rutilus*, stated that "Unter den europäischen kleinsäugern ist *M. oeconomus* nicht der einzige, der zur Zeit mit Unrecht als palearktisch gilt. Soweit ich aus eigener Anschauung sehe, haben die Rötelmäuse (*Cl. rutilus*, vielleicht auch *glareolus*), . . . ebenso ihre amerikanischen Unterarten, nur sind diese Zusammenhänge zur Zeit durch nomenklatorische Schwierigkeiten verschleiert." Recent American workers have considered *C. dawsoni* to be specifically distinct from *C. rutilus*. In his study of the *C. dawsoni* group, Orr (1945, p. 69) pointed out the similarities of the two forms, but his material was apparently inadequate to allow the comparisons necessary to better understand the relationships involved.

In the opinion of the writer, there is no further justification to consider *Clethrionomys dawsoni* as having full specific rank, since all differences from *C. rutilus* are so slight as to be subspecific in nature. The American races should stand as follows:

Clethrionomys rutilus dawsoni (Merriam)
Clethrionomys rutilus glacialis Orr
Clethrionomys rutilus insularis (Heller)
Clethrionomys rutilus orca (Merriam)
Clethrionomys rutilus watsoni Orr

Microtus oeconomus macfarlani Merriam

Tundra voles were trapped rather commonly in certain habitats, usually in wet tundra areas, at altitudes up to 2,000 feet. They were never so abundant, where observations were made, as was *Microtus miurus*. *Microtus oeconomus macfarlani* was collected both at Tolugak Lake and at Umiat; it probably occurs in all suitable habitat in this region. In general, the summer specimens were darker in color than is considered typical for this subspecies. Two subadult specimens, collected during early June, showed a peculiar buffy color dorsally—apparently a characteristic of the winter pelage, since molting was in evidence. They were cranially identical with the present species. A total of more than 30 specimens was obtained.

According to the work of Zimmermann (1942), with which the writer agrees after having examined pertinent material, the Alaskan *Microtus operarius* is conspecific with *M. oeconomus* of Eurasia. Gilmore (1946) regarded *M. operarius* as conspecific with *M. kamtschaticus* of Siberia; however, according to Zimmermann, *kamtschaticus* is a subspecies of *M. oeconomus*. Several subspecies were previously assigned to the Alaskan *M. operarius;* of these, according to Anderson (1937), *M. operarius endoecus* is identical with *M. o. macfarlani*, the latter name having priority. With this one change, Zimmermann's classification of the *Microtus oeconomus* group of Alaskan voles is as follows:

Microtus oeconomus operarius Nelson
Microtus oeconomus macfarlani Merriam (syn. *endoecus* Osgood)
Microtus oeconomus yakutatensis Merriam
Microtus oeconomus kadiacensis Merriam
Microtus oeconomus unalascensis Merriam
Microtus oeconomus popofensis Merriam
Microtus oeconomus sitkensis Merriam
Microtus oeconomus innuitus Merriam
Microtus oeconomus punukensis Hall and Gilmore
Microtus oeconomus elymocetes Osgood

Microtus miurus paneaki, n. subsp.

Voles of the subgenus *Stenocranius*, apparently representing a new subspecies of *Microtus miurus*, occurred very commonly near Tolugak Lake, and also were collected at Umiat.

Type.—Skin and skull, young adult male, U. S. N. M. no. 290296; collected at Tolugak Lake (lat. 68° 24′ N., long. 152° 10′ W.), Brooks Range, Alaska, June 2, 1949, by Robert Rausch, original no. 21.

Range.—Type locality and vicinity; also taken at Umiat, on the Colville River.

Diagnosis.—Size medium. Five adult males measured: Total length 151 (140–170); tail 26 (23–30); hind foot 20 (19–21) mm. Five adult females measured: Total length 151 (146–155); tail 25 (22–29); hind foot 20 (20–21) mm. The males averaged 39.2 (32.3–46.1) grams in weight; the females (all pregnant) averaged 40.9 (32.2–51.2) grams. Dorsal ground color between Ochraceous-Tawny and Yellow-Ocher (capitalized terms are from Ridgway, *Color standards and color nomenclature*, 1912). Purest color on rump and flanks. Entire dorsal surface with heavy admixture of dark brown to black hairs, resulting in general grayish appearance. Ear patches ochraceous-buff, similar to rump. Sides tawny, shading into grayish on underparts and into ochraceous-buff on flanks. Some specimens more buffy on underparts. Dorsal surface of tail ochraceous-buff, with pale buff underneath. Feet gray. Skull long and narrow as typical of subgenus. Molar pattern as typical for species.

Table 1.—Cranial Measurements (Average) of Various Subspecies of Clethrionomys rutilus

Subspecies and locality	Number examined	Sex	Length of tooth row	Condylobasal length	Zygomatic width	Interorbital width	Mastoid width	Length of nasals
Clethrionomys r. rutilus:								
Lappmark	8	?	4.6	23.5	12.9	3.9	11.1	6.8
Siberia	9	♂	4.5	22.7	13.1	3.7	11.1	6.9
Clethrionomys r. jochelsoni:								
Northern Siberia	29	♀	4.6	22.7	12.9	3.7	11.1	6.7
Do	28	♂	4.6	22.7	12.8	3.7	11.0	6.6
Clethrionomys r. dawsoni:								
Tolugak Lake, Alaska	6	♀	5.1	23.4	13.0	3.9	11.1	7.2
Do	6	♂	5.1	23.6	13.0	4.0	11.4	7.3
Chignik and Charlie Creek, Alaska	14	♀	4.9	23.7	13.3	3.9	11.4	6.9
Do	10	♂	4.9	23.6	13.3	3.8	11.4	7.4

Comparisons.—Microtus miurus paneaki is differentiated from *M. miurus oreas* Osgood by more grayish color, strongly contrasting lateral streaks, and less over-all ochraceous coloring. The skull of *paneaki* averages larger than that of *oreas* and is slightly narrower cranially. The molar patterns are identical. From *M. miurus miurus* Osgood, *paneaki* differs in more grayish color, presence of a contrasting ochraceous flank streak, larger and more massive skull, longer and heavier rostrum, larger and more inflated bullae, and much heavier molars. Compared with the type specimen of *Microtus muriei* Nelson, the present form differs in much heavier and broader skull, wider zygomata, more inflated bullae, and more widely separated tooth rows. The molars are much heavier, and the interorbital depression is slighter in both immature and adult specimens. Two other obviously related species, *Microtus andersoni* Rand, 1945, and *M. cantator* Anderson, 1946, are both smaller than *M. miurus paneaki* and differ cranially and externally. Specimens of *andersoni* and *cantator* in the Collection of the National Museum of Canada have been examined by the writer.

More than a hundred voles of this species were collected near Tolugak Lake; they were very abundant in this vicinity during the summer of 1949. They were taken at altitudes from about 2,000 feet to above 3,000 feet. Their runways were numerous on the dry mountain slopes, often where vegetation was scarce.

This vole is named for my friend Paneak, one of the native Inland People, whose generous cooperation has contributed much to the success of the field work in the Brooks Range.

Lemmus trimucronatus alascensis Merriam

Although not so abundant as along the Arctic coast during 1949, the brown lemming was not uncommon at Tolugak Lake during September; about 15 specimens were taken during this time. Only a single specimen was captured there previously. An immature specimen was captured at Umiat, and the skull of an adult was taken from the stomach of a rough-legged hawk (*Buteo lagopus*), which was nesting on the bluffs of the Colville River near Umiat.

Dicrostonyx groenlandicus rubricatus (Richardson)

Only six specimens of this lemming were collected in the Brooks Mountains during 1949, and none was observed at Umiat. Additional observations would indicate that this species was generally uncommon during 1949 over the whole of the Arctic Slope. About 15 specimens were collected near Point Barrow, during a time when the brown lemming was exceedingly abundant.

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ANTHROPOLOGY.—*New data on the inland Eskimo of northern Alaska.*[1] RALPH S. SOLECKI, Bureau of American Ethnology.

The intensified reopening of Alaska to exploration and investigation by the U. S. Geological Survey from the beginning of World War II (Reed, 1949a) has been accompanied by the promotion of new lines of scientific research. This is especially true in northern Alaska, where until recently anthropology—including its subscience archeology—had been limited to only the coastal areas or those parts of Alaska that were reasonably accessible (Larsen and Rainey, 1948, pp. 30–31). It should also be understood that, as yet, the surface has only been scratched even in those particular areas.

The express purpose of this paper is to make an appraisal of the archeological resources and possibilities for further research in the interior around the headwaters of the Colville River basin, which is situated in one of the lesser-known domains of the Territory of Alaska (Fig. 1). The government land known as Naval Petroleum Reserve No. 4 includes much of this area, which was part of the former homeland of the Nunatagmiut Eskimo, an inland people.[2] Such information as could be gleaned from related sources is included to furnish the background material for this study. This is necessary in order that our present findings may be properly correlated with previous accounts of the inland peoples. The area under scrutiny is one of the three places within the Eskimo habitat where "we do find genuine inland tribes" (Birket-Smith, 1936, p. 109). Unfortunately enough, anthropological data concerning this region are available to us now only in terms of its prehistory and from accounts of early explorers. No anthropological studies were actually made of living inland Eskimo within the Colville drainage basin.

The writer, an archeologist, was afforded an opportunity to accompany one of the U. S. Geological Survey parties during the summer of 1949 through the joint cooperation of the Bureau of American Ethnology of the Smithsonian Institution, the U. S. Geological Survey, and the Office of Naval Research. The results of his archeological investigations of the Kukpowruk and Kokolik Rivers in northwestern Alaska are in preparation, a preliminary report having been written (Solecki, in press).

Umiat, the Survey base of operations, was the assembly point of the field parties. The writer spent a few days there at the start of the season before leaving for his particular area in northwestern Alaska. Taking advantage of the opportunity, he briefed the five other Geological Survey parties in the collecting of archeological material. These parties were to examine the heart of the interior of Arctic Alaska in the lower central portions of Naval Petroleum Reserve No. 4 (Reed, 1949b). The principal drainage basin there is the Colville. It was hoped that enough field data might be collected by these geologists to furnish the framework for an overall reconnaissance report covering some of the archeology of this section of the inland region. Naturally it was physically impossible for the writer personally to communicate further archeological information once the groups had set out. The nature of the geological work kept these scientists widely separated, the writer's party being farthest removed from Umiat.

Happily, the archeological information

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[1] Received March 30, 1950.

[2] The range of the Nunatagmiut Eskimo as described here is illustrated on Seltzer's map (1933, p. 320).

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submitted by the geologists at the close of the field season was ample enough to permit the drawing of some inferences and conclusions. In addition, information on Eskimo sites noted by the geologists in previous years was also included. The evidence collected by men of heretofore little or no acquaintance with archeology indicates what a fertile field of investigation lies before the trained field worker there. The writer wishes to express his thanks and appreciation to those geologists from the Survey parties who supplied him with the archeological material for this report. Without this data the present appraisal of the Colville basin area and its environs would have little tangible or factual basis other than the documentary sources.

The archeology of the interior north of the Brooks Range has been literally unknown, with the exception of a brief, though important, archeological paper by Thompson (1948), a geologist who led a Survey party on the Utukok River in 1947 (Fig. 2). Helge Larsen (Larsen and Rainey, 1948) made a reconnaissance in 1942 of the same river inland from its mouth. However, a detailed account of his finds is not yet published. Though Larsen's investigations and Thompson's report, as well as the present writer's survey, are part of the archeology of this inland area, they are omitted from this paper for the sake of brevity except in passing. J. L. Giddings, Jr. (1944), has furnished us with an archeological résumé of the Kobuk River area south of the Brooks Range where he worked for two seasons. References are made to the latter's report where his findings have a bearing on the present paper. In short, this presentation deals chiefly with the archeology of the Colville River basin including some other smaller river drainages emptying into the Arctic Ocean.

Most of the data on archeological sites listed here were submitted by the members of the Geological Survey field parties at the end of the 1949 season. A total of 42 sites are included in the tabulation from the interior. Historic and recent Eskimo camp sites were recorded on the Kuna, Etiviluk, Nigu, Killik, Okpikrurak, Okokmilaga, Ayiyak, Kiruktagiak, Chandler, Nanushuk, Sagavanirktok, Shaviovik, and Canning Rivers. In addition, data were supplied from abandoned settlements, undoubtedly Eskimo, on Chandler Lake, Kanayut Lake, Itkillik, and Schrader Lakes. A total of 128 chert flakes and artifacts were recovered by the Survey from 6 archeological sites on Maybe Creek and the Kuna and Etiviluk Rivers. The writer found evidence of aboriginal occupation on a lookout station near Umiat on the Colville River.

The technique of stone chipping and the materials used in the manufacture of artifacts are of a quality which the writer (Solecki, in press) has classified as Colville Basin

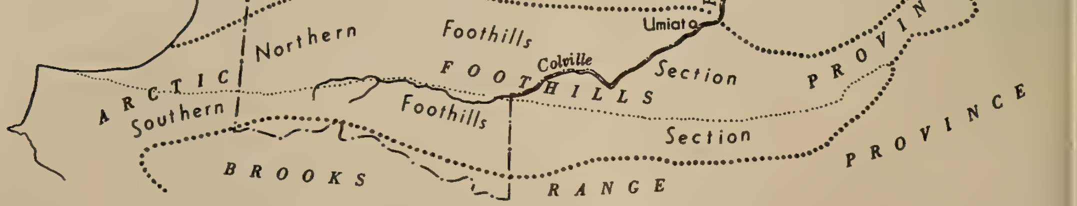

FIG. 1.—Map showing location of Naval Petroleum Reserve No. 4 and physiographic provinces of the Arctic Slope. Reproduced by permission of the U. S. Geological Survey.

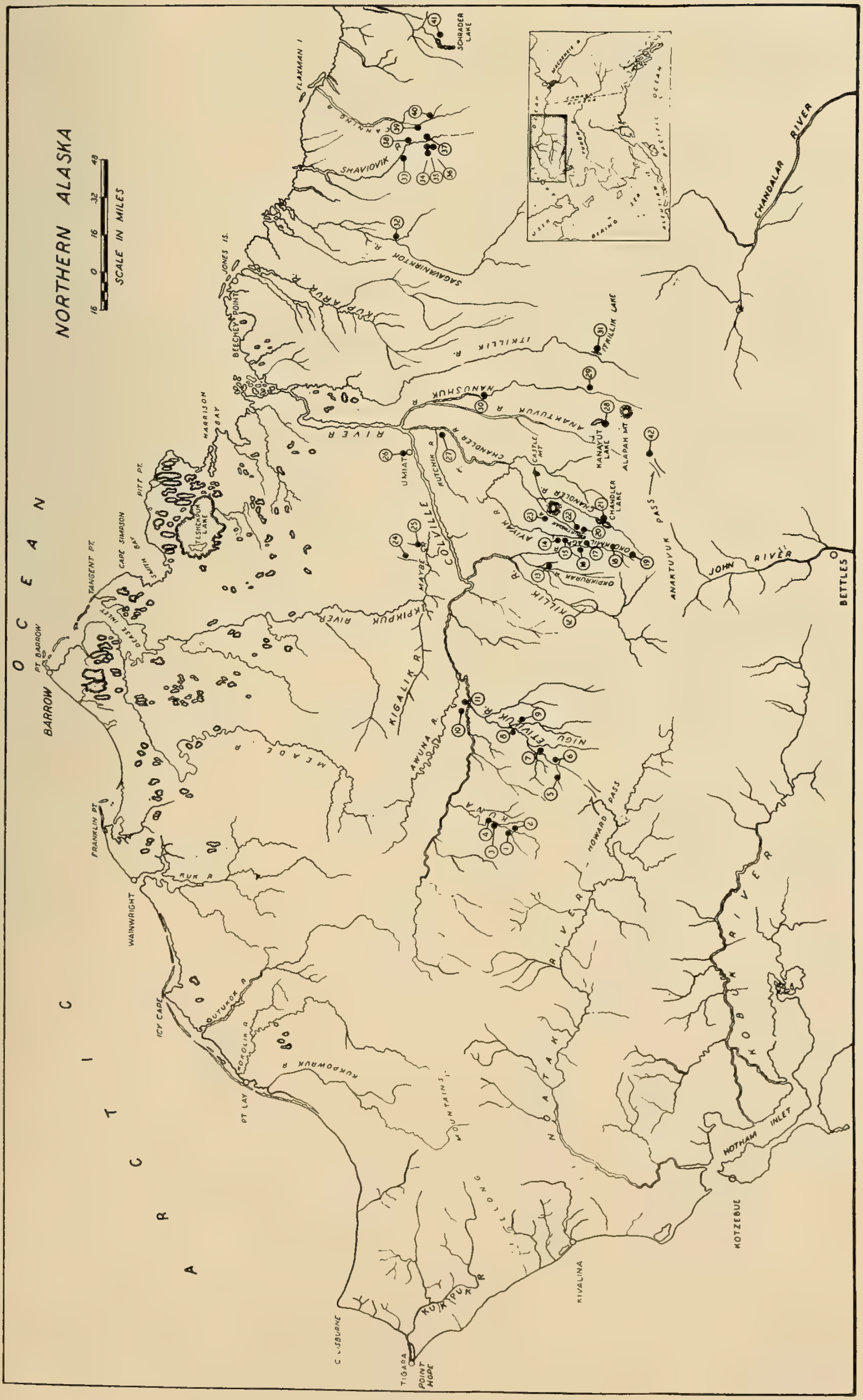

FIG. 2.—Map of northern Alaska showing the archeological sites in the interior.

Phase, or precontact Eskimo culture. Eight recent objects of more perishable nature were found on Itkillik Lake and in Anaktuvuk Pass.

THE COUNTRY

The area under exploration comprises some 70,000 square miles of desolate country north of the Brooks Range. The latter is a great mountain barrier stretching 600 miles across the north, beyond the Arctic Circle and the tree zone. The character of this region has been best described by Smith and Mertie (1930) in their *Geology and mineral resources of northwestern Alaska*. This admirable piece of work includes, like many other geological publications, data collected by the Survey parties which is of interest to the other sciences, including archeology.

Physiographically, the region between the Arctic Ocean and the mountains, or the north slope, is divided into three provinces (Fig. 1). These are the Brooks Range Province, the Arctic Foothills Province, and the Arctic Coastal Plain Province. They extend east and west in parallel bands of approximately the same width across northern Alaska, tapering together somewhat at the opposite ends.

The Brooks Range Province is composed of rugged glaciated mountains reaching a height of about 9,000 feet. It represents the Alaskan counterpart of the Rocky Mountains. Rising out of the west, this chain is breached near the middle by several important passes connecting with stream drainages to the south.

The Foothills Province is characterized by low hills and ridges. It is divided into two sections—the more elevated Southern Foothills Section bordering the mountains and the more subdued Northern Foothills Section bordering the coastal plain. The ridges in the Northern Foothills Section are in an east-west alignment, a geomorphological phenomenon resulting from a linear warping of the underlying beds. The Foothills present a bleak undulating expanse. It is treeless except on the stream borders where occasional stunted growths of willows predominate.

The Arctic Coastal Plain Province, similarly treeless, looks half drowned because of the many standing pools, lakes, and sluggish meandering streams. The monotonous flatness of this area is relieved by a few isolated low knobs and hills, generally 50 to 100 feet in height.

As one expects, in the Arctic the winters are long and the summers short with a correspondingly short period of thaw. A natural phenomenon of this region is permafrost, or subsurface frozen ground, which extends in places to a depth of 1,000 feet. The annual precipitation of only 5 to 7 inches on the north slope accounts for its aridness, which combined with the frigid temperature permits the preservation of organic matter for deceptively long time spans.

Fronting the Brooks Range there are several large mountain-fed lakes that empty into north-flowing rivers. Some of these lakes are Chandler, Anaktuvuk, Kanayut, Nanushuk, Itkillik, Saganvanirktok, and Schrader. They extend partly into the southern section of the Foothills Province, and partly into the Brooks Range Province.

THE PEOPLE

The interior country, now well-nigh deserted, supported several thousands of Eskimos in the not too distant past. These inland Eskimos were different physically from the coastal Eskimo (Larsen and Rainey, 1948, pp. 24, 36; Rosse, 1883, p. 28). They were taller and bigger-boned than the coastal people, and their facial features were more akin to the Indian physiognomy (Cantwell, *in* Healy, 1889, p. 81). On the basis of anthropometrical measurements of a sample of 526 adult Eskimos,[3] among them Nunatagmiut people (72 adult males and 55 adult females), Seltzer (1933, p. 347)[4] concludes that "the Nunatagmiut do not exhibit any close relationships with the other Eskimos." Their physical features are all "Indian-like and clearly betray the presence of considerable blood that must have entered this group in comparatively recent times" (ibid.). The Indian mixture to which Seltzer refers is Athapascan. Some of the inland male Eskimos were 6 feet tall and over (Brower, 1942, p. 227; Rosse, 1883, p. 28). Seltzer (1933, p. 341) gives a mean stature of 169.12 ± 0.90 cm for the measurement of 26 male Nunatagmiut Eskimos, or about 5½ feet tall. However, these "present the tallest mean statures that heretofore have been assigned to any Eskimo" group (Seltzer, 1933, p. 342).

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[3] Data of Vilhjalmur Stefansson, collected from northern Alaska and the Coronation Gulf region in 1906–1912.

[4] Henry B. Collins, Jr. (1934, pp. 309–313), has discussed Seltzer's paper in a critical review, pointing out that the latter's conclusions relative to Eskimo cultural and somatological connections leave much to be desired. Collins's (p. 313) summary of the physical anthropology of the Eskimos indicates that much caution should be exercised in making any final conclusions on the subject of Eskimo origins, etc., at present.

It appears from the following reports that these nomadic peoples died in great numbers of starvation and disease in the latter part and at the turn of the nineteenth century (Brower, 1942, pp. 37, 228–229; 1949). Rosse (1883, pp. 16–24), a physician, deals with the diseases of the Eskimos at some length. His firsthand observations are particularly important since they were made when the native populations began to dwindle. Undoubtedly the inland Eskimo suffered from diseases and afflictions similar to those of the coastal Eskimo, whom Rosse observed. Howard (*in* Stoney, 1900, p. 74) in 1885 saw many sick people in the mountains, especially women and children, who appeared to suffer from severe colds. It was not long after this that the tragedy of influenza struck (Brower, 1942, pp. 228–229; 1949), probably resulting in the death of these very people. Brower (ibid.) recorded in 1900 that about 200 inland Eskimos, all visitors to Point Barrow who had contracted influenza there, died all along the way homeward, from the mouths of the rivers to the portage and to the Colville. The bodies of the dead, their boats, and belongings were found scattered everywhere on the inland routes. This catastrophe was followed two years later (1902) by an epidemic of measles, which caused 120 deaths at Point Barrow alone. Thus it was that the Eskimos, like other nonliterate peoples everywhere before them, finally felt the full impact of white man's diseases. There the populations were ravaged by smallpox, diphtheria, influenza, measles, and tuberculosis, among other diseases. Whiskey also contributed much to their debilitation (Rosse, 1883).

A few inland Eskimos apparently escaped extinction, since some of them came down the rivers to Barrow in 1908 and 1931 (Brower, 1949). No mention is made by Brower of visits of inland peoples between those years, an omission that seems to carry portentous meaning.

So far as it is known, there is only one band of truly inland north slope Eskimos left. This band, the Killik Eskimos, are divided into two groups of families numbering 40 or 50 persons including children. Living in the Southern Foothills region and the mountains near Chandler Lake, these modern Eskimos are still dependent on the caribou and the products of the hunt for their livelihood. The statement made by Larsen and Rainey (1948, p. 24) that "the vast Arctic slope north of the Brooks Range has been entirely abandoned only during the past 20 or 25 years," is not yet completely true, since there still survives the one band mentioned. Presumably it is to them that we owe the indications of recent camp sites in the neighborhood of the upper Colville and adjacent tributaries.

The ethnological record of the interior Alaskan or western Eskimos north of the Brooks Range is very meager, since none of the several northern interior tribes have been studied by anthropologists. We are helped with a few notes made by early explorers, notably Ray, Stoney, Healy (et al.), and Stefansson. The last small Eskimo groups mentioned above are dwindling away rapidly. The extreme inaccessibility of their habitat has probably been the paramount cause for their neglect and our lack of data.

Our knowledge of the historic inland northern Eskimos may be summed up in a few paragraphs. Stefansson (1914, pp. 9–11) mentions seven inland tribal bands, namely the Kuvugmiut, Noatagmiut, Nunatagmiut, Kangianirmut (Kanianermiurt), Oturkagmiut, Killiermiut, and Kagmallirmiut. These Eskimo bands were distributed over different important inland rivers. The name of a small band, Nunatagmiut,[5] nearly extinct at the time of Stefansson's writing (in 1908), has been applied collectively to all northern inland Eskimos by both whites and coastal Eskimos alike. The reason given was that this band was centrally situated near the head of the Colville River.[6] There seems to be some elusiveness and uncertainty about the use of this name. Birket-Smith (1936, p. 225) calls these inland Alaskan Eskimos the "Colville Eskimos" and assigns the Nunatagmiut to the Noatak River. Perhaps the best authority to speak on this subject is Stefansson (1914, pp. 10–11) who says:

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[5] Larsen and Rainey (1948, p. 24, pp. 30–36) refer to these inland Eskimos as "Nunatarmiut," having a distribution practically similar to Nelson's "Nunatagmiut" (Nelson, 1899, pl. 2). In order to avoid confusion, Stefansson's collective term "Nunatagmiut" is used in this paper.

> It seems fairly clear that the name of this smallest of all these inland tribes became recognized on the coast as the name for them all because they were centrally located. From the point of view of the Barrow people, the Nunatagmiut were south of the Oturkagmiut; . . . For each of these sections of the country, therefore, Nunatagmiut became the indefinite name that covered the people next beyond those who were personally known to the speakers, and thus the word obtained a comprehensiveness of meaning on the seacoast which it never had among the inlanders themselves. Now you find it in census reports and works of ethnology.

Recognized wintering places were many on the Colville and its tributaries. There is abundant evidence, as shown below, that the Nunatagmiut were on intimate terms with the natives of the Noatak and Kobuk Rivers across the mountains to the southwest, as well as with the Colville delta and Point Barrow Eskimos. They seemed to have served as middlemen in trading between these two regions.

The expeditions of Lt. P. Henry Ray, U. S. A. (1885), Capt. M. A. Healy, U. S. R. M. (1887, 1889), and Lt. George M. Stoney, U. S. N. (1900), made almost simultaneously in the early part of the 1880's, furnished some pertinent information about the inland Alaskan Eskimos. Lieutenant Ray, based at Point Barrow, made a short exploration of the Meade (Kulugrua) River to the south from its mouth to the foothills, or the mountains as he called them. He reached to about the seventieth parallel. Captain Healy's parties made exploratory boat trips up the Noatak and the Kobuk, mainly of a reconnaissance nature. Lieutenant Stoney, based on the Kobuk (Kowak, Putnam) River, made two trips into the interior mountain region, one up the Noatak, and the other up the Kobuk to Chandler Lake. One of Lieutenant Stoney's subordinate officers, Ensign W. L. Howard, made a memorable journey in 1886 between the headwaters of the Noatak River to Point Barrow via the Etiviluk, Colville, and Ikpikpuk (Chipp) Rivers (Fig. 3). These explorers followed native routes of travel and were accompanied by native guides. Some idea of Eskimo inland life can be had from a study of these firsthand reports. About this time in the latter part of the nineteenth century, inland Eskimo habitat north of the range seems to have centered in the southern Foothills Province, close to the mountains rather than in the northern part of the same province or in the Arctic Coastal Plain Province. This we gather from Ray and Stoney. The former (Ray, 1885, p. 38) writes: "Between Pt. Barrow and the Colville, the country is uninhabited in the winter. The resources of this region are so limited that in the struggle for existence, these people are obliged to devote all their energies and time to procuring necessary food and clothing to maintain life, never being able to get a sufficient supply of meat ahead to lay in a reserve; famine always stares them in the face should they try to relax their efforts." Similarly, at the time of Stoney's winter visit to an Eskimo village in the mountains on Chandler Lake, he learned that there were no natives between that inland lake and the northern coast (Stoney, 1900, pp. 44–45). It is very likely that the whole of the region below the headwaters of the rivers was forsaken during the winter or had been deserted as claimed below. Stoney tells us that only a few of the inland natives went to the Arctic coast to trade, the "majority continue in the mountains, living almost entirely on deer meat." Some of the Kobuk River natives came to pay them annual visits during the winter to trade and to hunt deer during their stay (Stoney, 1900, p. 45).

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[6] The Colville River, the longest and largest river on the north slope, was named by Dease and Simpson after Andrew Colville of the Hudson's Bay Co. in 1837. One of the Eskimo names for the Colville is "Kupik," meaning "big river." This was spelled "Gubik" by the geologist Schrader, who gave this name to the Pleistocene sand deposits in northern Alaska (Schrader, 1904, p. 93; Leffingwell, 1919, pp. 74, 95).

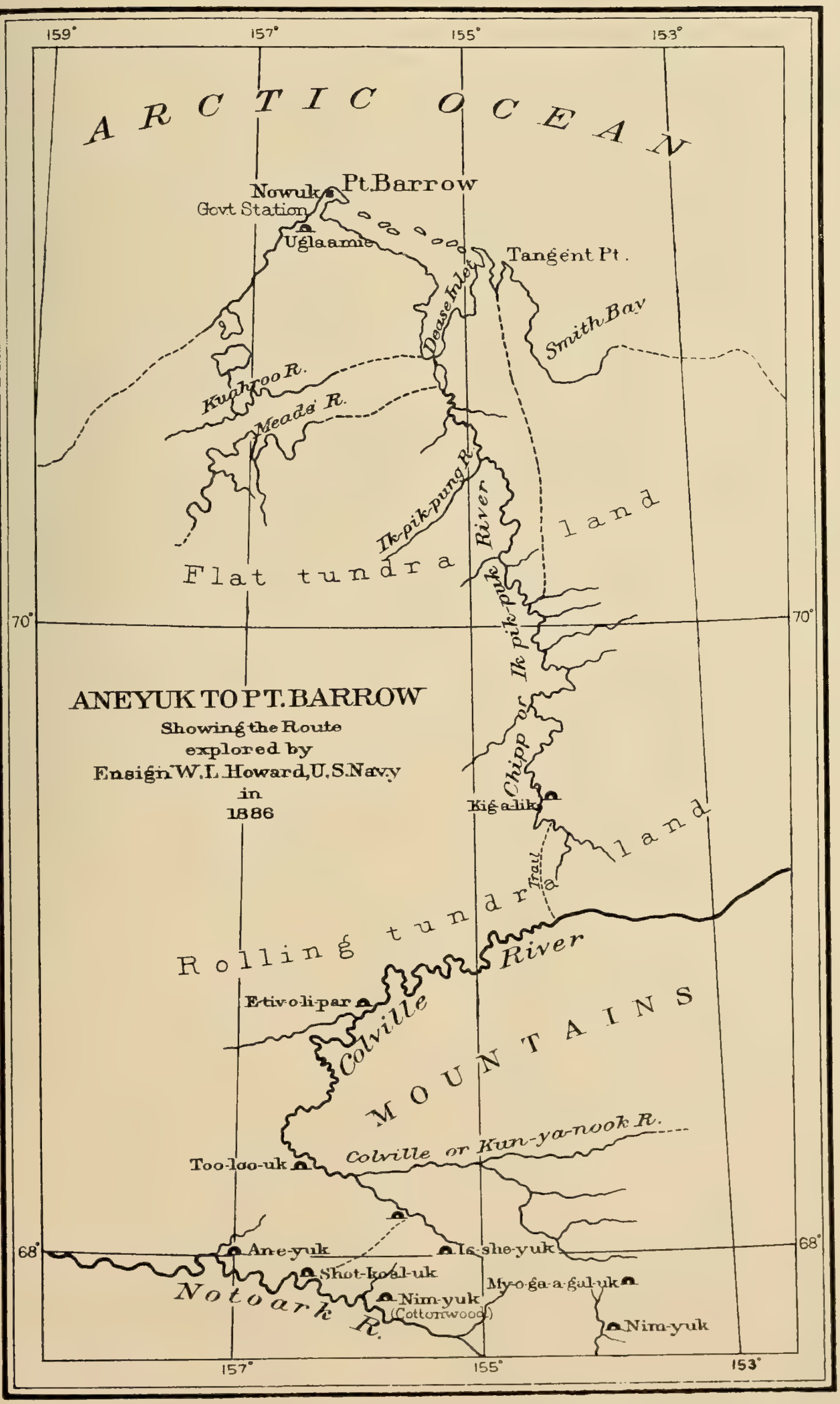

FIG. 3.—Map showing route of Ensign W. L. Howard, U.S.N., in 1886.

The natives at Point Barrow asserted to Ray (1885, p. 27) that the intermediate region (the Coastal Plain Province) between the Colville and Point Barrow had been inhabited three generations ago by people who lived there on fish and caribou.[7] These people did not come to the coast. Fish and caribou becoming scarce, the natives died of cold and starvation. The few that had survived went away to the Colville or joined other Eskimos on the coast.

Ray supposed that the ruins of winter huts built of turf he observed south of Point Barrow on the Meade River is the supporting evidence for this report. These huts were on a bank 50 feet high above the river According to Murdoch (1892, p. 27), who recorded ethnological notes on the Ray expedition, the natives of Point Barrow were unacquainted with the interior save for an area about 100 miles south of that station. These natives went into that area to hunt caribou during the months of February and March, returning between May 1 and 10 (Ray, 1885, p. 39).

Stoney (1900),[8] entering the inland zone from the southern side of the Brooks Range, gives us his descriptions of the interior Eskimo. He furnishes enough details, supplemented by Healy's reports, to make a fair sketch of the native economy and existence before these people disappeared.[9] Five inhabited villages were located on the interior rivers with northern drainages and one (Nudruvukpuk) on Lake Chandler. At the time of the explorer's writing, a great many of the mountain Eskimos had never seen a white man. Several of the native villages appear to have been important gathering places for either ceremonial reasons or as portage points. Issheyuk, a village near the northern limits of the Etiviluk River (a tributary of the Colville), and containing about 15 huts, seems to have been an important ceremonial place. Several hundred natives gathered there from all parts of the Noatak and surrounding territory for a big dance during the winter of 1885 (Stoney, 1900, p. 39). River rendezvous points were established at the end of navigation on the Colville and the Ikpikpuk on the north side of the range and on the Kobuk and Noatak on the south side. The Colville rendezvous, Etivilipar, is used as an example. This was a village situated at the junction of the Etiviluk and the Colville River. The trail to the mountain pass (Howard Pass) led up the Etiviluk River. At Etivilipar the natives going upstream in the fall put up their boats in order to wait for the snow to carry their sleds into the mountains. In the spring, on the other hand, those going downstream put up their sleds and took to the boats. This alternation from sled to boat and vice versa was a general convenient practice among the inland travelers (Larsen and Rainey, 1948, pp. 32–33). Kigalik, on the Ikpikpuk River, was another rendezvous village. It was at the end of a trail from the Colville, a short cut to Point Barrow. According to Howard, the Kigalik settlement consisted of 30 tents and 150 natives, all waiting to go down river to Point Barrow. They boated down with the flood waters just after spring breakup, when a swift voyage was assured on the meandering rivers. Some tribes, like the inland Noatak Eskimos, returned to the coast each spring, hunting in the mountains during the winter. Only a few families of these remained in the mountains (Howard *in* Stoney, 1900, p. 67). Presumably the Eskimos on the peripheral drainages of the interior, such as the Kobuk and the Noatak, spent much time in the mountains during the winter, since that season is the longest in the north. Larsen and Rainey (1948, pp. 32–34) describe the seasonal migration of the Utukok Eskimos to the Arctic coast. There appears to be proof in the statement that some Nunatagmiut Eskimos did not migrate to the coast, presumably because of the distance involved. The surviving "Killik" Eskimos of Anaktuvuk Pass, described below, are an example. They seem to have had no direct connections with the coast in either the present or past, so far as could be ascertained recently.

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[7] "Caribou" (*Rangifer tarandus arcticus*, or Barren Grounds caribou), is the French-Canadian word for wild reindeer of North America.

[8] Since Stoney wrote his report 15 years after his visit, some errors or doubtful statements may have crept in.

[9] Stefansson wrote in 1908 that the Colville people were starving and that the Colville area was too uncertain for food. The desertion of this region was remarked about among coastal Eskimos, a significant point (Stefansson, 1914, pp. 190, 208).

LIVELIHOOD

Caribou hunting dominated the livelihood and economy of these inland Eskimos. On the hills above the rivers were posts from which sharp lookouts watched for caribou. When the quarry was sighted, all the young men would leave for the chase. All work was suspended to hunt the caribou. The women brought in whatever was killed to be dressed and prepared. In the flat Coastal Plain Province, game kept to the lakes rather than to the river as in the Foothills. It seems that caribou were especially abundant on the headwaters of the Colville, Kobuk and Noatak Rivers in the mountains (Cantwell, *in* Healy, 1889, pp. 61, 80), which was no doubt the cause for native habitat there.

The caribou drive, requiring cooperative efforts, was not unknown to the Nunatagmiut. From the large herds as many as 25 caribou were caught by running them into a trap consisting of two converging rows of stone cairns terminating in a network of snares in the bushes. The cairns[10] were piles of stones about 4 feet high, resembling men at a distance. Shouts and flourishes from the side lines and the rear frightened the animals forward to what appeared to be a break ahead. The snares caught either the horns or the legs of the caribou, hampering them until they were despatched at short range by the hunters (Stoney, 1900, pp. 68, 74, 94). This method of trapping, one of several, is not unusual in the north (Larsen and Rainey, 1948, p. 34; Birket-Smith, 1936, p. 91). Charles Brower (1942, pp. 168–169; 1949) describes a caribou drive in the lake country. The caribou were driven between two long rows of sod cairns, which narrowed down to a point of land leading to a lake. The caribou, forced to plunge into and swim in the lake, were speared by hunters who lay in wait in their concealed kayaks. As many as a hundred were killed in these drives. Pitfalls (Brower, 1949, p. 34) dug in the snow were another means of trapping caribou. The pits were about 6 feet deep, 2 feet wide, and just long enough for the caribou to stand in without moving. The opening was disguised with a covering of willows overlaid with snow.

The inland Eskimo diet of caribou was supplemented by the meat of other animals such as bear, mountain sheep, and moose. Geese, ptarmigan, fish, and other edibles including berries were also eaten.

SHELTER

The inland Nunatagmiut appear to have had four kinds of habitations, and possibly a fifth. These were semipermanent and temporary dwellings. What seems to be an unusual type of the former structure held several families (Stoney, 1900, p. 46). A frame of mountain willows was the basic element of construction. This was generally long, low and narrow. Each family had its own ice-cake window, smokehole, and fireplace. There were ice windows alongside the doors at the ends. The frame, held up by a few uprights or "centerposts," was roofed with turf and reindeer moss. It was then covered with a layer of snow. Larsen and Rainey (1948, p. 35) describe another type of semipermanent inland Eskimo house with a single central fireplace. Quite substantial looking, semisubterranean houses, also semipermanent, with central fireplaces, were uncovered by Giddings on the Kobuk River (Giddings, 1944). Probably there are similar archeological remains of these dwellings such as illustrated by Stoney (1900, p. 40 illus.) on the upper Colville. However, since all timber would have had to be imported for the center posts of this type of semipermanent house, it may be conjectured, not without reason, that a more simply constructed house was commonly built. In addition, a more simply constructed hut, readily adaptable to the nomad life, would seem to be preferable. The dome-shaped willow hut[11] met the needs of frequent movements readily. It was light in construction, and could be adapted for either summer or winter use. It was made by bending and interlacing willows to a dome-shape of less than man height, with a circular floor plan. A roof covering of deer skins sufficed for the summer. A layer of soft snow about 6–8 inches thick was patted on the surface, making the hut snug in the winter (Stoney, 1900, p. 46; Stefansson, 1914, p. 206). When one desired to shift winter camps, the tent and poles were taken down from the inside, leaving the snow house up unless broken. To what extent the conical skin hut or "lodge" (E. W. Nelson, 1899, pp. 231, 242) was used in the Colville basin we are not certain. However, there seems to be adequate documentation supporting the dome-shaped as the prevailing type of dwelling. Healy (1889, pp. 80–81) mentions the dome-shaped hut on the Kobuk. Marvin Mangus, of the U. S. Geological Survey, has observed recently the plaited and bent willow frames of this house type on the Killik River on the north slope. The method of construction of one of these huts is illustrated by Leffingwell (1919, pl. 8B). The latter also shows a winter camp in use. Without doubt this is one of the easiest temporary dwellings to construct when on the move. A dome-shaped hut is also certainly the most feasible type of house to erect with native willows in the absence of larger trees.

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[10] Many of these structures still may be seen on the ridges in the Foothills Province.

[11] Jenness (1934, p. 402—footnote, p. 412) feels that "some inland Eskimo of northern Alaska" copied the dome-shaped hut from the Kutchin Indians of the Athapascan linguistic stock.

Larsen and Rainey (1948, pp. 56–57) believe that the dome-shaped, snow-covered tent is the prototype of the real snow house. The latter presumably finally developed in the central regions of the Arctic. Howard (*in* Stoney, 1900, p. 67) mentions huts in the mountains made of blocked snow, with roofs "formed by overlapping the higher layers."

TRADE

The Eskimos of the Kobuk and Noatak Rivers held a kind of summer fair at the head of Kotzebue Sound,[12] where extensive trading negotiations took place. Parties of traders from East Cape, Siberia, and the Diomede Islands introduced the intercontinental flavor with their wares (Nelson, 1899, pp. 228–232). There was a flourishing trade among the Kotzebue Bay people, the Nunatagmiut and the Point Barrow people. Jenness (1934, p. 23) lends additional weight in the following statement: "A hundred years ago there was a well defined trading route that commenced at Anadyr, the Russian mart near Bering Sea, crossed Bering Strait to Kotzebue Sound, then continued overland to the mouth of the Colville River and eastward to the delta of the Mackenzie." It seems quite plausible to hypothecate Eskimo migrations along this route.

Certainly the introduction of sleds and dog traction affected travel and trade considerably. However, we have archeological evidence indicating that these were comparatively late innovations. Giddings's data (1944, 1948) unearthed on the Kobuk has important bearings on this subject. Ahteut, the oldest Eskimo site on the Kobuk River uncovered by Giddings (1944, pp. 123–124, 127), shows absence of any signs of sledding or dog traction. Giddings has given a date of A. D. 1200–1250 for Ahteut, part of a continuous dendrochronological record of 970 years in Alaska. Evidences of sleds first appeared among the Kobuk River people in the first half of the sixteenth century, and "swivels, etc." for dog traction after 1700 (Giddings, 1948, p. 32). Presumably this would also hold true for the prehistoric Eskimos of the Noatak River and the Colville Basin drainage. Absence of dog traction and the sled would necessarily hinder winter family movements, confining travel to the open waterways during the summer season (Giddings, 1944, p. 124). Hence, we must infer that since travel through the mountains to the northward-flowing drainages was to be negotiated by portage, the natural difficulties inherent without dog traction or sleds made such travel prior to their introduction probably either out of the question or very infrequent. This, of course, applies more specifically to seasonal long-distance journeys. Consequently, we might expect that the northern interior areas were not visited by many Eskimo family groups until after dog traction and sleds were introduced in about the sixteenth century, at least for the latter innovation. There is archeological evidence indicating that these two traits were also comparatively late in other places (Collins, 1937, pp. 338–341; Larsen and Rainey, 1948, p. 186). It is possible that there were year-round occupations of the mountain areas prior to these introductions. Proof of this would have to wait on archeological investigations.

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[12] Kotzebue, the "native trading rendezvous" located on Healy's map (1887) at the junction of the Kobuk and Noatak Rivers on Hotham Inlet, Kotzebue Sound, is probably the age-old trading point still in use. The present status of Kotzebue archeology is summarized by Giddings (1944, pp. 128–130).

Resuming our discussion of inland trade, Stefansson (1914, p. 10) observes that the Eskimo from the Colville area obtained "Asiatic and other wares" from the trading rendezvous on Kotzebue Sound. Trade over the mountains from the southern drainages to the Colville headwaters was accomplished in a 10-day portage during the winter (Cantwell, *in* Healy, 1887, pp. 45–46). Stoney (1900, p. 39) said that the mountain natives went to Point Barrow every summer, proof of which he saw in the army clothing worn by them, evidently obtained from the Army post formerly under the command of Lieutenant Ray at Point Barrow. A family or two often stayed on the northern coast for a visit during the winter. There was a regular exchange of definitely needed goods and some luxury items between the inland people and the coastal natives. The former Eskimos had caribou skins, mammoth-tusk ivory, tent poles, and wood to trade for seal-oil, rifles, blubber, seal skins, tobacco, etc. (Stoney, 1900, p. 68, 76; Larsen and Rainey, 1948, p. 33). Jade, a highly prized commodity for trade, was secured from the upper Kobuk River in the central part of that valley basin. This widely traded material was mined only under the observances of certain taboos according to the early explorers (Stoney, 1900, p. 46). Chert for the manufacture of flaked implements was traded to the Point Barrow Eskimos from the Nunatagmiut. It was generally a black or a translucent gray chert (Murdoch, 1892, p. 60).

Trade and traffic between the drainages north and south of the Brooks Range depended on passes over the divide. Good pass routes through the mountains are limited. Three good ones (Fig. 2) athwart the Endicott Mountains of the Brooks Range were probably used exclusively for traffic and trade. They connect fairly well with a minimum of portage between the drainages of the Colville River and the southern rivers. Howard Pass joins the headwaters of the Noatak with the Etiviluk River, a branch of the Colville. Stoney approached Chandler Lake going over the mountains by another route at the headwaters of the Kobuk River, through a low pass now known as "Survey Pass."[13] The third good pass to the north is Anaktuvuk Pass, which leads from John River on the south side of the divide to the northward-flowing Anaktuvuk River. This route, followed by Schrader (1904, pp. 21–22) in 1901, is the one which the surviving "Killik" Eskimos use today between Chandler Lake and the town of Bettles on the south side of the mountains. Six different mountain trail crossings were used by the geologists as shown on the "Geological Reconnaissance Map of Northwestern Alaska" (*in* Smith and Mertie, 1930, pl. 2). Three of these (Howard Pass, Survey Pass, and Anaktuvuk Pass) have been mentioned above. The others are situated in the western sector of the Brooks Range. The latter passes were probably not as much favored as the more direct links between river drainages, since they are a bit too far westward for easy connection.

RECENT INVESTIGATIONS AND FINDINGS

By the time the geological surveys[14] of the early twentieth century explored the north over a generation ago, the inland settlements had vanished, and no recent signs of large communities were found. As Smith and Mertie (1930, p. 110) said, "even signs of old habitations are rare." These authors note that there were signs of man on many of the prominent knobs north of the Brooks Range, indicating that these promontories had been used as lookout stations by caribou hunters. The ruins of 15 or 20 huts were seen on the headwaters of the main branch of the Colville River, above its junction with the Kuna River. These huts had obviously been deserted for a long time. With the exception of two old willow hut frames, some discarded tin cans and other recent camp debris, no indications were found of the large settlement where Howard waited three or four days at Etivilipar on his trip to Point Barrow. The only aboriginal artifacts specifically mentioned by Smith and Mertie were "exceptionally well fashioned" spear heads. These were found on the Awuna River, a short distance above its juncton with the Colville, near an old native camp site. Evidences of an encampment were found near the summit of Birthday Pass in the same area. The remains of a village site were found in the basin of the Ikpikpuk River a few miles above the junction of Kigalik River and Maybe Creek. This site appears to mark the north end of the portage from the Colville (Smith and Mertie, 1930, p. 111). These geologists noted that:

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[13] Called "Navy Pass" on Stoney's map (1900).

[14] John C. Reed (1949a, b) has given us an inkling of the recent survey work in northern Alaska in two articles. Up to the present, no full account has been released. Smith and Mertie (1930, pp. 8–27) give a summary report of the Geological Survey work done in the north between 1901–1926. Earlier investigations are included by the above authors in the same work on pp. 4–7.

> This place must have been at one time the home of numerous natives, as is indicated by the worn-out and discarded gear and ruins of houses, many of which were dug down several feet below the terrace flat on which they were built. Large willow tripods, evidently used for hanging up meat, showed that this place had probably been last used by hunters, but the rotten condition of the rope and canvas which together with willow withes had been used for fastening the legs of the tripods proved that they had not been used for many years. A few miles farther downstream, at the junction of the Kigalik River and Maybe Creek, there are indications of a formerly very populous settlement. This is undoubtedly the village noted by Howard in 1886 as Kigalik, which at the time of his visit consisted of 30 tents and 50 natives.[15] No huts remain, and the tract does not appear to have been used even by chance travelers for many years.

There were many signs of smaller former occupations or camps farther down on the Ikpikpuk River. Summarizing Eskimo habitations and occupations in the north, Smith and Mertie (1930, p. 112) state, "The same general conditions prevailed in the valleys of all the other rivers flowing into the Arctic Ocean. On none of them were there any occupied settlements, and on few of them were there any signs of camps that had been used for any length of time recently."

One wonders, however, how many and which of these sites are attributable to coastal Eskimos on the hunt, or to "genuinely" inland Eskimos or both. It would seem that the smaller camps may possibly be those of wandering hunters coming up the rivers from the coast.

Some data, part of which is given below, were collected with reference to the sole survivors of some true inland mountain Eskimo by George A. Llano, botanist for the Department of Botany, U. S. National Museum. Dr. Llano had occasion to visit the Anaktuvuk Pass area at the headwaters of the Anaktuvuk River during the summer of 1949. He took some photographs and made some observations. The Anaktuvuk Pass area where the "Killik" Eskimo camped was favorably situated. According to Dr. Llano's report, these mountain people rarely if ever came down to the seacoast. They are nomadic hunters; their main means of subsistence are the caribou. The Killik Eskimo travel back and forth between Bettles, where they winter, and the Anaktuvuk Pass area, Chandler Lake, and environs, where they spend the summer. These Eskimos are divided into two groups of families, one of which is headed by Simon Paniak who is said to be an able leader. This group consists of five families. Each family has about four members, which makes a total population of about 48 individuals in the Killik tribe. Though these Eskimos are often completely isolated, they are not without contact from the outside world. They have guns and other equipment. One of the richer men (the best wolf hunter) owned four portable radios and other knickknacks purchased with the wolf bounty and furs. Like the other Eskimos, they are quite adept at using mechanical equipment and can improvise readily. In one instance, they patched up the wrecked float of a seaplane well enough for it to take off again. Their best routes of travel are up and down rivers following the natural levels. There is abundant occupational evidence and ruins marking old unmapped camp sites in Anaktuvuk Pass. In their tradition, as far back as the Killik Eskimos can remember, they have always camped in this region. These natives sincerely wish to have an education. They mistakenly moved bag and baggage to the Anaktuvuk Lake area thinking that school would be held there during the summer of 1949. For the present, no teacher has been provided for them.

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[15] The number of natives was evidently a misprint, since Howard (*in* Stoney, 1900, p. 71) saw 150 Eskimos at Kigalik.

INLAND ESKIMO ORIGINS

The origin of these inland Alaskan Eskimos is in doubt. Birket-Smith (1936, p. 112) believes that the Colville and Yukon Eskimos originally lived on the coast in the usual manner and wandered inland. This implies that the coastal Eskimos had followed up the drainage systems nearest them. Stefansson (1914, p. 23) suggests the possibility on a linguistic basis that the Eskimos may have worked their way westward into Alaska along the Arctic coast and followed the shore around down to Kotzebue Sound. From there, Stefansson continues, a branch of the coastal Eskimo may have traveled up the Noatak River, across the divide, and back down the Colville. Certainly this clue should not be disregarded in the future unraveling of Eskimo archeology in the northern interior. Seen in the broader perspective, we still at best must theorize about the origins of Eskimo culture in North America. As Collins (1940, p. 583) points out, "The archeological discoveries in the north, instead of providing immediate evidence of the origin of Eskimo culture, have shown that it will be necessary to extend our search still farther into the past if that origin is to be revealed."

THE ARCHEOLOGY

Of the 42 sites listed below in the appendix, the majority were found in the central portion of Naval Petroleum Reserve No. 4 (Fig. 2). Data were supplied for 38 of these sites by the field party chiefs and members of the U. S. Geological Survey.[16] Two sites (nos. 8, 11) were native encampments visited by Howard in 1886. One site (no. 26) was found by the writer during a brief stay at Umiat. The Anaktuvuk Pass area is indicated as one site (no. 42).

Eskimo occupational evidence has also been noted by geologists exploring the northeastern parts of Alaska within the past few years. These remains were seen on the Sadlerochit, the Hula Hula, and Jago Rivers, but no details can be given.

It must be kept in mind that the geologists, specializing in their own work, were not trained archeologists. Their descriptions are entered below as accurately and as fully as possible. Enough data were recovered to make a positive assertion that archeological materials are to be found over a widespread area in the interior of Arctic Alaska.

The specimens are described at the end of this section. The chipped stone artifacts from sites 1, 2, 4, 7, 9, and 30 were retained by their finders.

The sites are arbitrarily numbered on the map, following the different drainages from west to east. No numerical differentiation is made between old and recent Eskimo sites. The assemblage of sites may be divided into three divisions on the basis of the reported associated evidence. These are (a) precontact Eskimo sites, (b) recent Eskimo sites, and (c) sites of indeterminate age, presumably Eskimo.[17] The information is insufficient to indicate whether or not the sites in group (c) belong to group (a) or (b).

The archeological material from group (a) examined by the writer is similar to that classification of precontact Eskimo flaked artifacts he has called "Colville Basin Phase" (Solecki, in press). No sites of pre-Eskimo origin were reported, or more specifically, no specimens of recognizable pre-Eskimo origin were recovered. An especially important point to carry in mind is that undoubtedly many archeological sites had been passed over by the geologists in the field. Since evidence indicating precontact sites is not particularly easy to find even by trained archeologists, these sites as reported by the geologists are in the minority.

The sites in group (a) were lookout stations, or places where the hunters lay in wait for game. Presumably in their leisure, the lookouts flaked their knife blades and projectile points, hence also the name "chipping station" for these places. These stations were generally situated on low promontories with a good view of the surrounding country, usually near a river or creek. Howard probably saw some of the same lookout stations on the Etiviluk River in use when he went down that river in 1886 with the inland Eskimos.

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[16] The party chiefs and personnel of the U. S. Geological Survey who supplied the information are listed below. The site numbers of those particular sites which they reported are added to their names.

Arthur L. Bowsher: Sites 28, 29, 31.

William D. Brosgé and Alan Kover: Sites 24, 25.

Robert L. Detterman and Marvin D. Mangus: Sites 1–7, 9, 10, 12, 30, 36.

William W. Patton and Irving Tailleur: Sites 13–20, 22, 23, 27.

George Gryc: Sites 21, 28, 32–35, 37–41.

[17] Included in group (a) are sites 1, 2, 4, 7, 9, 25, 26, 30; group (b) sites 3, 5, 8, 10–13, 15, 16, 18, 20–23, 27, 28, 31, 32, 37, 38, 40–42; group (c) sites 6, 14, 17, 19, 24. 29, 33–36, 39.

The stone rings appear to be of two types: (1) Flat stones laid in a circle, and (2) rings of stone arranged for a hunter's blind or windbreak. The former arrangement of stones was presumably for the tent floor and weights to hold down the edges of the tent. The blinds were constructed by either piling stones on the flat sides, or propping them up on edge high enough to conceal the hunter or hunters. A hunting blind could serve equally well as a windbreak—almost a necessity on the hills and ridges where the wind could whip up uncomfortably in gale force during freezing temperatures. The "house" circles of stone were found along the rivers as well as on the hills above them.

Only one of the reported stone house circles (site 29) seemed to have a fireplace in the center. Unfortunately, it was not further investigated.

Stone trail markers and cairns are present on some of the ridges. The cairns, usually in an alignment, are evidently part of the Eskimo caribou drive (site 17).

The recent Eskimo camps were rather obvious to their finders. The camp debris generally consisted of cut willow boughs, hut remains, tin cans, drying racks, discarded clothing, large quantities of animal bones, etc. The animal bones represent the whole animals, including the heads and feet.

Evidence was found on a site (no. 20) on Kiruktagiak River indicating that the Eskimos used oil shale for fuel. This is nothing new however, since the Nunatagmiut burned it at least 64 years ago (1886) on the Etiviluk River (Stoney, 1900, p. 69).

How much of the recent evidence is attributable to the occupancy of the Killik Eskimos is not certain. However, since these people are apparently the only inland Eskimos who are dwelling in this region in any numbers at present, it does not seem farfetched to assume that they are responsible for the principal, if not all, of the recent occupational remains. The domain of the Killik Eskimo is not known for certainty, but they probably kept to within 75 to 100 miles of Anaktuvuk Pass in the Southern Foothills Section. The recent occupational remains found by the geologists on the drainages in the northeastern part of Alaska might be evidence of native hunters from the coastal region. On this point we are not certain at present.

Every one of the sites indicated in the tabulations will bear reexamination by a trained investigator. In addition, new sites undoubtedly would be found and recorded in the course of a survey. Presumably "key" sites may be located, such as the portage places mentioned by Howard, and seen by later geologists (Smith and Mertie, 1930, p. 111). How much pre-Eskimo material there is at present on the north slope can only be speculated on at this time. However, since this region was one of the unglaciated places close to the Asiatic-American bridge, there is hope of recovering this data. One Folsom point, reported by Thompson (1948) has already been found on the Utukok River in northwestern Alaska, and the writer (Solecki, in press) has found two sites bearing so-called "Mongolian" cores and flakes on the Kukpowruk River in the same section of Alaska.

CONCLUSION

It has been demonstrated above that archeological evidence is not lacking in the interior of Arctic Alaska beyond the tree zone. It has been shown that along the larger drainages and on the hills overlooking the valleys, especially in the Foothills Province, there may be discovered cultural material pointing to occupation by a prehistoric population or populations. We know from documented sources that Eskimos inhabited or at least frequented the north slope in the nineteenth and early twentieth centuries. These people were physically different from the Coastal Eskimos, being taller and more Indianlike in features (see *The People*, above). At this writing only one surviving band of inland Eskimos, the Killiks, is still dwelling in the mountains.

The greatest single difference between the inland Nunatagmiut Eskimos and the coastal Eskimos appears to be their economy or method of subsistence, as observed by Larsen and Rainey (1948, p. 35). The Nunatagmiut depended almost wholly upon caribou for their meat, shelter, and raiment. Probably like so many nonliterate societies dependent on one economy, when the ecological balance was upset, the Nunatagmiut culture was doomed. So far as can be gleaned from limited literary sources, it was scarcity of game, principally caribou, which was the prime cause for the desertion of inland northern Alaska and the extinction of these peoples. Sickness also played a major part in the depopulation.

It appears that the Nunatagmiut were "habitually inlanders" (Weyer, 1932, p. 157) who had interrelations with the coastal Eskimos via the larger drainage systems on both sides of the mountain divide. Certainly the inland region was not uninhabited by indigenous populations when the first ethnologists arrived in Alaska. According to the little documentary evidence available, six inland bands, comprising the Nunatagmiut, had semifixed boundaries or "spheres of influence" on the several interior drainage systems. Their tribal relationships were recognized among themselves.

Some inkling of the movements of the postcontact inland Eskimos on the north slope of Alaska is suggested by the literature. Whether archeological work in the future might corroborate this is not certain. However, with further information we should be able to make a more definite statement concerning population movements. It is supposed that the Coastal Plain Province once supported a nomadic hunting population up to about the first quarter of the nineteenth century, when the scarcity of game forced them to leave that area. The starving survivors joined the coastal peoples, or went south to the Colville River area and its tributaries in the Foothills Province. Stoney met settlements in the mountain area above the Colville River in 1886. Stefansson tells us that this region in the Foothills reportedly could not support a native population in the early twentieth century. The dread epidemic that hit the visiting inlanders at Point Barrow undoubtedly had far-telling effects (Brower, 1942, pp. 228–229). The last chapter to this story of a losing struggle with nature is mutely told by the surviving Killik Eskimos.

There seems to be fairly abundant evidence of precontact Eskimo archeology on the north slope of Alaska, amply demonstrated by finds of chert flakes and artifacts and habitation remains. Material remains of pre-Eskimo origins have been discovered farther to the west of the Colville basin area (Thompson, 1948; Solecki, in press). It is to be presumed that pre-Eskimo data may be found in the central and eastern parts of northern Arctic Alaska in the future. Although the archeological evidence from the interior as represented here is sketchy, there seem to be no immediate grounds for supposing that the Nunatagmiut were descendents of the original Eskimo.

FUTURE ARCHEOLOGICAL INVESTIGATIONS

The program for future archeological investigations on the north slope may be concerned with several questions: (1) What is the extent of pre-Eskimo remains and distributions in reference to the Folsom point reported on by Thompson (1948) and the Mongolian polyhedral cores with associated material found by the writer in 1949 (Solecki, in press; 1950)? (2) Were there different contemporary prehistoric cultural groups inhabiting the north slope? (3) What was the origin of the Colville basin and mountain Eskimos—were they relatively late comers? (4) Could the retreat of the inland Eskimos and their final dispersion in historic times be ascertained by archeological means? (5) What were the relationships between coastal and interior Eskimo groups (Collins, 1943, p. 220)? (6) Were the inland Eskimo of the north slope more numerous than the coastal Eskimo in the aboriginal period (Larsen and Rainey, 1948, p. 24)?

These are a few of the more obvious questions that come to mind. As common with many problems, the investigation of one opens a host of others to enquiry and this certainly can be anticipated in future archeological research in northern Alaska.

APPENDIX

THE SITES

1. Two gray-green chert flakes and 10 black chert flakes were found on a ridge site 1 mile west of Kuna River. The area of the finds contained about 50 feet square. It was apparently a lookout station.

2. A lookout station was discovered on a ridge one mile from the Kuna River on the east side. Chert flakes and scrapers were recovered from a 100-yard elongate area parallel to the river. The specimens consisted of about 9 black chert flakes, 5 gray-green chert flakes, 1 dark gray chert flake, 1 light gray chert flake, 1 large broken worked gray-green chert flake, 1 red chert flake, and 1 gray-green chert flake, both of the latter showing use-retouch.

3. A recent camp site was found about 4 or 5 miles from the Kuna River on the west side. The evidence was camp debris consisting of caribou bones, tin cans, and willow bundles. One stone "ring" about 8 to 10 feet in diameter was associated with these remains on a hill top. There were many ridge markers leading up to this site and past it.

4. On a bluff and ridge overlooking the Kuna River from the east bank was found a lookout station, evidenced by chert artifacts and debris. This material was found in a 50 square yard area. Nine black chert flakes, 7 gray-green chert flakes, 4 gray-green chert flakes showing use-retouch, 1 gray chert scraper, and a fragment of a black chert blade were recovered.

5. About 8 miles back on Fay Creek, a tributary of the Etiviluk River, was found an Eskimo site consisting of 2 tent (?) rings of stone on a ridge top. No artifacts were discovered, but several broken animal bones and some broken willow branches were observed. This material seemed to be of recent origin, dating within the last 20 years at least.

6. One mile away from the Etiviluk River on the east side the geologists noted one stone ring, evidently a camp site. No other indications were seen.

7. Lower down on the Etiviluk River about 3 miles back on the east side and one-half mile from a lake was found a site measuring 30 yards square on a little knoll. This site yielded 65 dark gray chert flakes, 1 point end of a gray chert blade, 1 point end of a gray chert projectile point, and some well-decomposed fragments of bone. Many more sites were observed on the lower Etiviluk River, but no record was kept of them by the geologists. No additional finds of stone working industry were made on the river lower down.

8. Howard in 1886 reported a thriving inland Eskimo village (Tooloouk) in the general vicinity of the junction of the Nigu and Etiviluk Rivers.

9. A nodule of black chert and a fragment of a stemmed black chert projectile point were found on the east side of Nigu River. Other details of the discovery are lacking.

10. Evidence of a recent overnight camp consisting of some decomposed willow branches was found on the north side of the Colville River. Some trial markers were seen nearby.

11. Howard reported a village site (E-tiv-o-li-par) at the junction of the Etiviluk and Colville Rivers, apparently not far from site 10 on the same side of the Colville.

12. Twelve fairly recent Eskimo camp sites were found on the upper Killik River. The evidence, scattered broadcast, included cut willow boughs, tin cans, caribou skins, and mountain sheep and caribou heads. The geologists also found tent stakes outlining at least 8 to 10 tents. An old wooden boat was discovered amount the willow clumps in this area.

13. On a middle fork of the Okpikrurak River was found a recently abandoned camp consisting of 8 huts covered with caribou hides. There were willow frames or huts floored with brush covered stones. Many drying racks, and animal remains representing foxes, wolverines, caribou, and moose were noted. Empty cartridge cases, tin cans, discarded skin clothing and mukluks were found scattered about. At least 30 or 40 individuals probably occupied this camp.

14. Stones piled up around in a circle as for a blind were found on a ridge lookout on Fortress Creek, a tributary of the Ayiyak River.

15. A popular recent camp site was encountered on a gravel bar on the west bank of the Ayiyak River. The site was situated in a big willow grove. There was much camp debris littering the neighborhood, including boat stays and strips of sheet metal. Game was especially abundant in the locale. This area seems to have been particularly favored by moose.

16. A recent native camp site was found on the west side of the Okokmilaga River. No other details were given.

17. Several old camp sites were found on the east side of the Okokmilaga River, about 5 miles

south of the Brooks Range front, within the mountains. Fifty old-appearing, lichen covered stone cairns were found on a terrace overlooking the valley at the foot of a big mountain.

18. A recent Eskimo camp site was found on the right bank of the upper Okokmilaga River. This camp site seems to have been a main inland Eskimo rendezvous between Killik and Anaktuvuk Passes. There was evidence that children played games there.

19. Several weathered rings of stone were found on the divide of a ridge top.

20. A recent Eskimo camp site was located near the head of the Kiruktagiak River. Evidence was found indicating that the natives had used oil shales for fuel.[18] This material has fairly good burning qualities.

21. Chandler Lake was a favorite native resort. A camp site was situated at the lower part of the lake near a creek. There were recent graves among older ones, marked with crosses. Possible sites were reported on glacial moraines near Big and Little Chandler Lakes. There was a local supply of chert in the mountains, where cherty inclusions were to be found in the limestone.

22. Tin cans and other recent debris marked a native camp site on the east side of the Kiruktagiak River.

23. Two stone "rings" and some old willow boughs were observed up on a ridge top west of the Kiruktagiak River.

24. Several fragments of bone and some charcoal were discovered on a gravel bar of Anak Creek, a tributary of Maybe Creek. This evidence could have been transported and redeposited by stream action, according to the geologists.

25. Several chert flakes, scattered on two locations, were collected on a high ridge top above Maybe Creek.

26. Four black chert flakes were recovered on Red Hill, a good lookout station two miles to the northwest of Umiat.

27. Some old hut willow frames were noted on the Kutchik River. The site overlooked a broad valley.

28. A camp site was found on a little knoll on the southwest corner of Kanayut Lake, in a glaciated valley. It was situated near the mouth of a small stream. The evidence consisted of one tent stake of sharpened antler and a stone ring or circle of stones 6 or 7 feet in diameter. Scattered stones representing a possible camp site was observed on the opposite side of the lake. Additional occupational evidence was recovered in the area in the form of antler tent stakes, and a fairly new nickled-steel trap. Kanayut Lake (formerly Willow Lake) is the largest lake in the central part of the Brooks Range.

29. Three Eskimo camp sites are situated near the head of Nanushuk Lake. These sites are represented by three stone circles or house rings, approximately 6 feet in diameter. One of the houses had a depression in the center 12 to 14 inches deep and 2 feet in diameter. Apparently these remains were not recent, since they were covered with tundra and willows were growing from the depression.

30. E. J. Webber, formerly with the U. S. Geological Survey, found two long, narrow projectile points with side notched bases of green chert on a camp site near the Nanushuk River. These specimens are presumably in the finder's possession.

31. A large recent Eskimo camp site was reported on the east side of Itkillik Lake. From 20 to 30 hut remains were noted on a 200-yard stretch along the lake. The occupational evidence includes an iron ax, a wooden bow, wood net floats, tent stakes, empty nail kegs, shoe pacs, tin cans, khaki trousers (no skin clothing), pieces of string, hundreds of saw-cut caribou skulls and bones, and an abundance of willow boughs. This was an extremely good camp location, since there were plenty of caribou in the nearby area, and the willow clumps grew to about 6 or 7 feet high near the creek. There is good fishing in the lake, with grayling and trout from 30 to 32 inches long.

32. The rotted remains of a sled were observed on a camp site at a stream junction of the Sagavanirktok River. A fallen cross, probably that of a grave was also seen, although no evidence of burial was found. There were indications of a prospector habitation or marker farther up the river.

33. One windbreak or hunter's blind[19] of

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[18] Howard (*in* Stoney, 1900, p. 69) on his journey down the Etiviluk noted that the native Eskimos were using shale (presumably oil shale) for fuel.

[19] Stefansson (1914, p. 211) found what appears to have been similar constructions on about every "fifth hill or so set up by man" at Cape Parry. He specifically mentions a half circular wall of stones about 10 or 12 feet in diameter. The stones weighed about 300 or 400 pounds apiece.

sandstone prominently situated on a ridge top was noted on the west side of the Shaviovik River. Associated with this structure were several .44-caliber cartridge shells. Evidences of excavation for iron ore was found nearby.

34, 35, 36. Windbreaks or hunter's blinds were discovered on high prominent ridges west of the Shaviovik River. These structures were constructed of sandstone. There were two conspicuous blinds on the ends of the ridges.

37. Debris of a recent Eskimo camp littered an area on the east side of the Shaviovik River. Bear skulls, tin cans, and discarded clothing made up part of the refuse.

38. A recent Eskimo encampment marked by tin cans, caribou skulls, and coffee cans was located by the geologists on the upper central Shaviovik River.

39. Four or five hunting blinds of stone were found erected on a ridge top above the Canning River on the west side.

40. Several recent Eskimo camp sites were noted on the Canning River at Shublik Spring. The latter is an open spring. The camp remains included mountain sheep bones and skulls, coffee cans, and the wooden boom of a sail boat.

41. Remains of a fish net discovered on the shore of Schrader Lake points to native occupancy there. No other evidence was noted.

42. Evidences of recent and old Eskimo occupations were observed by Dr. George Llano, of the Department of Botany, U. S. National Museum. He recovered an Eskimo crooked knife, an antler projectile point, and a small wooden toggle from this site.

THE ARTIFACTS

The Nonlithic Material

Recent Eskimo material was brought back by Arthur Bowsher,[20] one of the leaders of the Geological Survey parties. Mr. Bowsher found the following specimens at Itkillik Lake (site 31). The items (Fig. 4) described below were all surface finds.

1. One crudely fashioned although still serviceable iron ax with a wooden handle. The head, which is not very rusted, has an expanded blade, which has been resharpened recently. The handle is 55 cm long. The opposite end has also been inserted into the ax head hole. There are 7 holes about 0.5 cm in diameter through the flat part of the handle. It may have been part of a sled runner. (Fig. 4, *a*.)

2. A net sinker float of light wood, 8 cm long and 5.3 cm in diameter across the flat ends. There are two holes for suspension on the net, one at each end of the float. The holes are on the same axis and are bored in from the sides at an angle. (Fig. 4, *b*.)

3. One saw-cut caribou tent stake 29 cm long. The antler is divided lengthwise by a saw cut. The point is saw-sharpened. (Fig. 4, *f*.)

4. One saw-cut caribou antler 41.5 cm long. There is a slot at the distal end, 3 cm deep and 1.5 cm. wide. There is a constriction below the slot which probably facilitated hafting. (Fig. 4, *g*.)

5. Half of a willow bow, 55 cm long. The bow is curved and has a nock for the bow string on the distal end. It is broken at the handle. (Fig. 4, *h*.)

Dr. Llano recovered three specimens at Anaktuvuk Pass (site 42). These items (Fig. 4), described below, were found on the surface.

1. An antler projectile point 11 cm long and 0.7 cm thick. It is slightly curved and pointed at both ends. The tang of this arrowhead is encircled by a projecting ring, similar to that illustrated for Tigara by Larsen and Rainey (1949, fig. 51d). This is but slightly different from the modern type point. (Fig. 4, *c*.)

2. A wooden toggle 9.5 cm long and 1.1 cm thick, well fashioned and smoothed. There are rounded knobs at both ends formed by cutting away part of the stock. (Fig. 4, *d*.)

3. One carved antler handle of an Eskimo crooked knife 34 cm long. An iron blade had apparently been fastened at the distal end. There are four holes drilled through the handle. (Fig. 4, *e*.)

All the above artifacts are undoubtedly of recent Eskimo origin. It is difficult to determine from the condition of these pieces themselves how old they might be, since material does not seem to deteriorate in the Arctic as rapidly as in more temperate climatic zones. The evidence of saw cuts, knife cuts, etc., certainly points to post-White contact origins.

The Illustrated Lithic Material

The illustrated lithic specimens (Fig. 4) are typical of the entire lot available to the author for examination. Four sites are represented in the following order: Site no. 2 (*i*); no. 4 (*k*, *l*, *m*, *n*); no. 7 (*o*, *p*); no. 9 (*i*, *q*).

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[20] Now of the Department of Geology, U. S. National Museum.

1. A long specimen of light greenish chert (Fig. 4, *i*) appears at first glance to be merely a reject. However, it seems to be a unique reject. The face shown in the illustration exhibits primary percussion flaking, the longest side exhibiting secondary chipping. This latter feature is ap-

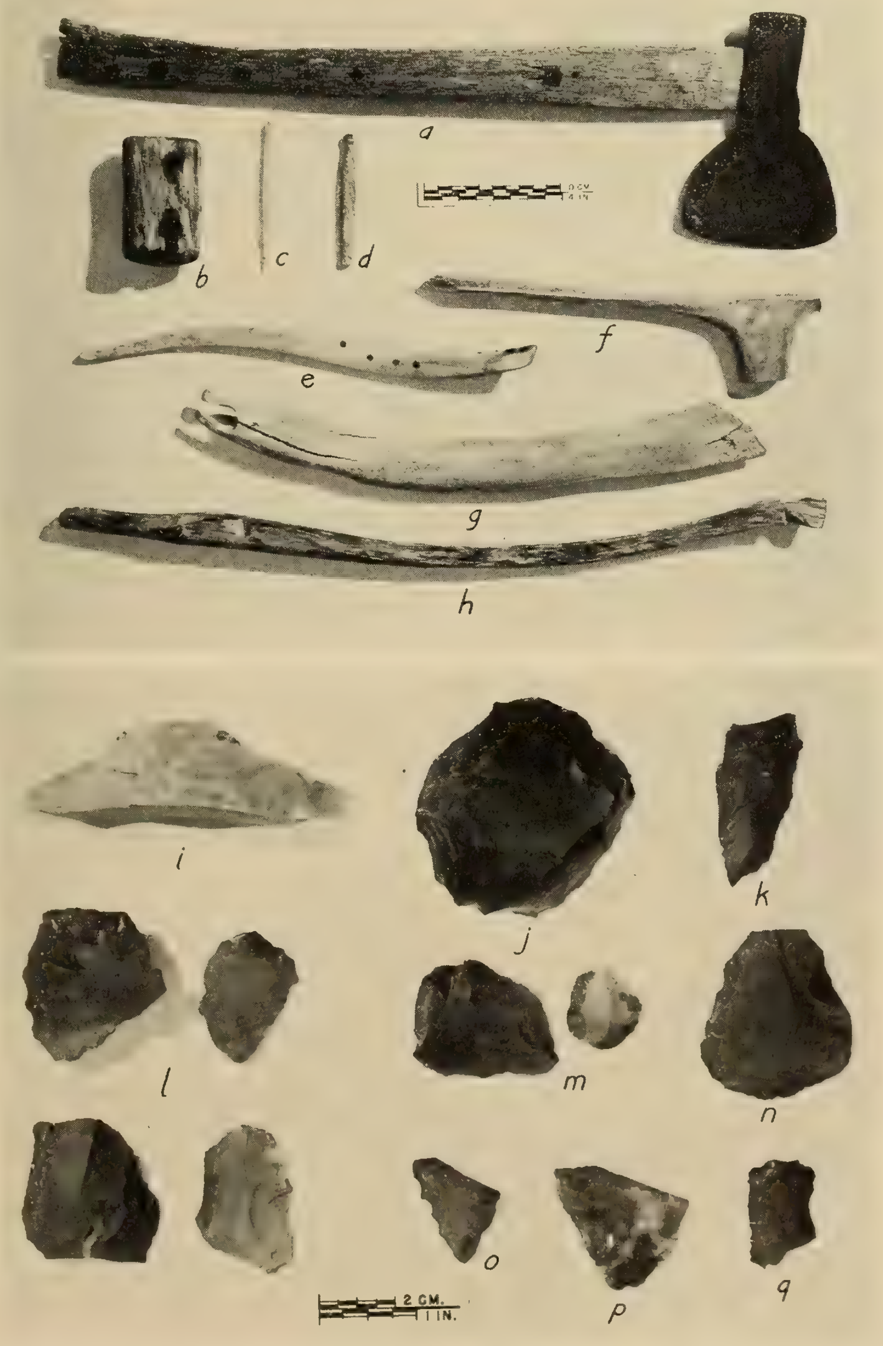

FIG. 4.—Artifacts from interior Alaska. Nonlithic material: *a*, ax; *b*, net float; *c*, antler arrowpoint; *d*, wooden toggle; *e*, handle of crooked knife; *f*, tent stake; *g*, hafted antler; *h*, piece of bow. Lithic material: *i*, Worked reject; *j*, nodule; *k*, reject blade fragment; *l*, ordinary flakes; *m*, use-retouched flakes; *n*, end scraper; *o*, *p*, point ends of projectile point and blade; *q*, midsection of projectile point.

parently derived from use-retouch. The specimen is quite thick for its proportions near this edge, or 2.8 cm at the greatest thickness. It presents a flat surface on the underside almost at right angles to the axis of the face plane.

2. A reject nodule of black chert (Fig. 4, *j*). The ends were heavily battered by poorly controlled percussion blows from all sides. This is evidenced by the flake surfaces and the bulbar scars. The specimen is approximately 2.2 cm in average thickness. It is apparent that the flakes did not carry well across the specimen, bringing about obdurate knobs on the surfaces of the specimen.

3. A fragment of reject material (Fig. 4, *k*). It is evidently part of a broken blade quite thick-bodied in cross section. There appears to be some secondary retouching on the edge which indicates poor flaking control.

4. This is a group of four ordinary chert flakes (Fig. 4, *l*) typical of the percussion-struck variety found in the Colville Basin area. These flakes are universally common on workshop sites even to comparatively recent times. They are illustrated in order to indicate what type of common workshop debris material may be expected on chipping stations in the north. The two upper flakes exhibit the inner or ventral surface with the bulb of percussion at the top. On the two lower flakes are shown the outer or dorsal surfaces with the characteristic oblique flake beds.

5. Two examples of chert flakes (Fig. 4, *m*), which evidently had been used for some cutting or scraping function. The perimetrical edges, originally sharp, had been blunted and chipped in this process. The resulting effect is called a "use-retouched" flake.

6. A simple flat end-scraper of dark gray chert (Fig. 4, *n*). It shows some pressure flaking and use-retouch on the lower, broader end. This specimen was originally a large spawl adapted for use as a scraper.

7. The point end of a broad gray chert projectile point (Fig. 4, *o*) which has been pressure flaked. The flaking shows poor control of the technique.

8. The point end of a broad gray chert blade or projectile point (Fig. 4, *p*) which appears to have been percussion flaked. The resulting effect is clumsy in shape and finish.

9. This is the midsection of a modern type, pressure flaked, stemmed, long and narrow black chert projectile point (Fig. 4, *q*). It exhibits well-controlled pressure flaking, which was carried at right angles to the parallel sides of the artifact. The excellent quality of the workmanship contrasts sharply with that found on the rest of the lithic specimens recovered in the Colville basin.

Discussion of the Lithic Material

The flaked artifacts and the waste stone material are of local cherts, probably derived from Lisburne limestone occurring in the mountains. An examination of these artifacts and flakes discloses (with the exception of one specimen) that they are typologically similar to those which the author has designated as Colville Basin Phase material (Solecki, in press). The identical materials and the chipping and flaking technique may be duplicated on the majority of the artifacts from the Kukpowruk, Kokolik, and Utukok River chipping stations. The single exception, a broken long-stemmed projectile point (Fig. 4, *q*), exhibits expert controlled pressure flaking.

An examination of these flakes and artifacts discloses that the percussion method seems to have been used almost exclusively in the manufacture. None of the flakes, which are the majority of the specimens, are of any singular distinction. They are of the type sometimes referred to as "nondescript." Examination of the flake faces shows that the blank was not juxtaposed in any set manner to receive the blows of the hammer. Apparently the blows were directed from varying degrees of obliqueness across the face of the nodule. Further study of the flaking technique shows that the majority of the flakes had been struck off from the core or blank at an angle approximating 120°. This angular measurement is determined by measuring the angle between the axis of the flake plane and the axis of the striking platform. The striking platform is represented on the flake by a small flat area above the bulb of percussion where the detaching blow had been struck. This apparently again exhibits one of the limitations of the manipulability of materials with conchoidal fracture, which falls in with N. C. Nelson's studies (1938, p. 158). More recently Watanabe (1948) has illustrated and described the same phenomena in Japan.[21]

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[21] The writer is indebted to Ferdinand Okada, of the Department of Anthropology, Columbia University, for the translation of Watanabe's article.

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BIOLOGY.—*A consideration of mineral nutrition of boxwood in relation to infection by meadow nematodes*, Pratylenchus spp.[1] A. C. Tarjan, University of Maryland. (Communicated by G. Steiner.)

Plant nematology is a comparatively recent science. To date, most of the investigations in this field have been concerned mainly with a study of the pathogenic nematodes, the diseases they cause, and possible means of control of these diseases. A few German workers (*9*, *15*, *17*) have conducted chemical analyses of infected plant parts, but these have been principally on plants infected by the sugar-beet nematode, *Heterodera schachtii* Schmidt, while most of the other nematode-induced plant diseases have not yet been studied as to mineral requirements of the plant hosts.

Certain meadow nematodes, members of the genus *Pratylenchus* attacking the roots of boxwoods, can cause a pronounced decline of these plants (*13*). Symptoms appearing on the above-ground parts are described as an unhealthy appearance of the plants resulting from partial to almost complete defoliation, unnatural reddening or chlorosis of the leaves, and stunted growth. An inspection of the root system shows a dwarfed bushy type of growth with a pronounced absence of deep feeding roots. A close observation will reveal brown to black lesions, which usually girdle the roots and eventually cause a sloughing off of the cortical tissues, leaving the fibrous vascular cylinder exposed. It is therefore quite apparent that any plant thus impaired can not long survive without soon indicating in the above-ground parts the deteriorated condition of the root system. Similar symptoms have been observed in the case of other plant nematode diseases. Shaw (*11*) states that the foliage of beet plants, whose roots are invaded by the sugar beet nematode, assumes a lighter green color than normal, with subsequent more severe discoloration of the foliage and death of the plant. Infected plants appear to have an abnormally large number of lateral rootlets. These observations parallel those of Tyler (*14*) who worked with the root-knot nematode, Cobb (*4*) who investigated the activities of the burrowing nematode, *Tylenchus similis* Cobb, and Steiner (*12*) who described symptoms caused by various members of the genus *Pratylenchus* on several types of plants.

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[1] Division of Plant Pathology, University of Maryland, Paper no. 95. Contribution no. 2203 of the Maryland Agricultural Experiment Station. Received February 3, 1950.

On the basis of the symptoms on boxwood foliage described above, it may be suspected that infected plants are suffering from deficiencies of essential elements. The American Plant Food Council (*1*) states that nitrogen deficiency causes a sickly, yellow-green color with a slow, dwarfed mode of growth of the plant. Potash deficiency manifests itself in a mottling, spotting, or streaking of the leaves, while magnesium deficiency results in a loss of green color with definite and sharply defined yellowish-green streaks throughout the leaf. Almost all these symptoms are noticeable in the early stages of the boxwood nematode disease. Kramer and Schrader (*6*) found, in a study on the deficiency symptoms on the Cabot variety of *Vaccinium corymbosum* L., that a magnesium deficiency caused one sharply defined symptom in particular: the leaf margins became chlorotic while the tissue near the midrib remained green. A secondary stage of the deficiency resulted in the chlorotic areas turning red and necrotic. A similar condition is found in infected boxwood leaves and has been, in the past, attributed to either drought or winter injury. In a series of tests by Keyes (*5*) on *Gardenia veitchii* Hort., it was found that a potassium deficiency caused chlorosis of the leaves as well as a cessation of growth; further, that calcium deficiency resulted in a breakdown of root tissue starting at the tips of the roots. New roots were not produced and as the disintegration of the root system progressed, wilting occurred. Although in nematode-infected boxwood roots there occurs a breakdown of the roots inhabited by nematode colonies, this has been attributed to the destruction of the cortical tissues by the nemas which are usually situated between the healthy and deteriorating portions of the rootlet.

Vaňha (*15*) analysed the dry matter of the roots of nematode-infected sugar beets and found lower percentages of phosphorus, magnesium, and calcium and a decidedly lower percentage of potassium in the infected roots in contrast to the healthy. Wilfarth and Wimmer (*17*) likewise found that infected sugar beets had lower percentages of nitrogen, potassium, sodium, calcium, and magnesium. They concluded that the plants were deprived of nutritional substances due to the presence of the nematodes, and stipulated that an abundant potassium fertilization would maintain the proper sugar content within the beets but would not prevent a lowering of the yield. They assumed that proper yields could be maintained only by a comprehensive and abundant fertilization program. Roemer (*9*), however, was able to increase the yield of nematode-infected sugar beets from 18,000 to 19,000 kg per 2.47 acres by applying only a potassium fertilizer.

It can therefore be seen that in the case of certain plant nematode diseases there is a marked reduction in certain of the nutritional elements contained in the plants. The present investigations were undertaken with the objective of correlating the disease symptoms expressed by boxwood plants infected by meadow nematodes with a possible excess or deficiency in the amounts of some of the elements required for normal growth by the plants.

MATERIALS AND METHODS[2]

A total of 48 6-month-old dwarf English boxwoods, *Buxus sempervirens* var. *suffruticosa* L., which had been rooted and grown under comparable conditions, were transplanted into a potting medium of approximately one-third sand and two-thirds soil in 5-inch pots. These were separated into two groups of 24 plants each. One and one-half grams of finely chopped, healthy boxwood roots were incorporated into the soil in each pot in one group, while 1½ grams of finely chopped meadow nematode-infected boxwood roots were applied to the soil in each pot in the other group.

After six months of growth, all plants were washed and weighed. The mean weight per plant in each group is presented in Table 1. The plants were then dried for 48 hours at approximately 125°F. The 24 plants in each group were then separated into six lots of four plants each, and each lot was further separated into stem, leaf, and root samples. These were ground in a Wiley Mill equipped with a 60-mesh wire screen.

Ash solutions were prepared and analyzed for nitrogen, phosphorus, and magnesium by methods suggested by Lindner (*7*). In the preparation of reagents for the determination of nitrogen, Nessler's solution was prepared according to Vanselow (*16*).

Potassium, sodium, and calcium readings were obtained by use of the Beckman flame spectrophotometer.

Boron was determined by the same methods proposed by Berger and Truog (*2*, *3*) except that the color comparisons were made by use of a Coleman spectrophotometer at a wavelength of 610 millimicrons (*10*).

TABLE 1.—WEIGHT COMPARISONS BETWEEN HEALTHY AND MEADOW NEMATODE-INFECTED BOXWOODS.

	Healthy	Diseased
Weight in grams	18.6* ± 1.2	14.6† ± 0.7

* L.S.D. at the 1-percent level is 2.6.
† Each value represents the mean of 24 replicate plants.

RESULTS

As can be seen in Table 2, the amount of calcium in the diseased stem, leaf, and root samples was higher than in the healthy samples. This is contrary to the results of Vaňha (*15*) and Wilfarth and Wimmer (*17*), who found, in working with sugar beets infected with the sugar-beet nematode, that there was a lower amount of calcium in the diseased tissues than in the healthy.

The differences in boron content between healthy and diseased samples were insignificant.

Magnesium was higher in healthy stems, diseased leaves, and healthy roots. Other investigators (*15*, *17*) had not found differences in magnesium (in oxide form) to be very great in analysis of healthy and diseased sugar beet plant parts.

Sodium was higher in diseased stem and leaf samples while in root samples it was higher at the 1-percent level of significance.

Nitrogen was higher in healthy stem and leaf samples while in root samples it was

TABLE 2.—MINERAL CONTENT OF HEALTHY AND DISEASED BOXWOODS EXPRESSED IN MILLIGRAMS PER GRAM OF OVEN-DRY SAMPLE

Mineral	Stems		Leaves		Roots	
	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased
Boron	0.005* ± 0.002	0.007 ± 0.002	0.036 ± 0.006	0.043 ± 0.008	0.002 ± 0.001	0.007 ± 0.005
Calcium	0.48 ± 0.13	0.83 ± 0.15	1.53 ± 0.11	1.88 ± 0.18	0.35 ± 0.05	1.02 ± 0.16
Magnesium	5.83 ± 0.88	4.92 ± 1.00	15.67 ± 0.38	16.75 ± 0.79	7.42 ± 0.93	6.08 ± 0.79
Nitrogen	22.60 ± 2.65	21.10 ± 0.54	41.50 ± 0.74	40.20 ± 0.69	37.20 ± 1.39	47.60† ± 1.67
Phosphorus	1.50 ± 0.22	1.70 ± 0.16	2.70 ± 0.10	3.70† ± 0.27	2.89 ± 0.26	3.20 ± 0.14
Potassium	2.10 ± 0.03	2.07 ± 0.14	5.43† ± 0.32	1.88 ± 0.18	5.00† ± 0.18	3.33 ± 0.11
Sodium	0.50 ± 0.07	0.82 ± 0.54	0.68 ± 0.05	0.82 ± 0.05	0.48 ± 0.05	1.03† ± 0.16

* Each value represents the mean of six composite samples.
† Significant at odds of 99 to 1.

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[2] The author expresses sincere appreciation to Dr. L. E. Scott, Department of Horticulture, University of Maryland, for his valuable suggestions, guidance, and criticisms during the execution of the chemical determinations involved.

significantly higher at the 1-percent level in diseased samples as compared to healthy samples.

Phosphorus, as in the case of nitrogen, was higher in diseased stem and root samples than in healthy samples and was significantly higher at the 1-percent level in diseased leaves than in healthy leaves.

Potassium in healthy stem samples was higher than in diseased stem samples, while it was significantly higher at the 1-percent level in both the leaf and root samples as compared to the diseased.

DISCUSSION

The results presented above appear to be due to the deleterious effects of feeding of meadow nematodes on the roots of box wood plants. It may be that the gradual rotting away of the root system due to the nematodes is cardinal in instigating the decline and eventual death of the plants, but here one would assume a proportionate decrease in the level of all minerals contained in the stems and leaves rather than a decrease in some and an increase in others as occurred. Then too, one should not preclude the fact that secondary invaders, which are in constant association with the nematodes, may be the real pathogens which cause the decline of these plants. Since Koch's postulates can not be proved for this disease, as well as for diseases caused by viruses or by other obligate parasites, we can not definitely assert that the meadow nematode is the primary cause of decline in boxwood, but must be content with stating that this nematode is almost constantly associated with this disease.

Another very important possible cause of decline in boxwood is brought to light by the work of Linford (*8*) who found that various types of nematodes, such as *Aphelenchoides* spp., *Ditylenchus* spp., and *Aphelenchus* spp., have esophageal glands that are salivary in nature. He observed that the above-named nemas ejected fluid from their esophageal glands into the root tissues of the host while feeding. These fluids, which are strongly digestive in nature, functioned in the breaking down and digestion of the tissues and were then sucked back into the nematode body. Linford concluded that "destructiveness may be closely related to the volume and composition of the saliva injected into the tissues, rather than to the ability of the parasite to destroy tissue by mechanical means." Following Linford's reasoning, we find that inspection of the meadow nematode microscopically reveals three rather large esophageal glands, which undoubtedly play an important role in the feeding of this parasite. It may actually be then that the symptoms of this disease are, for the most part, a response of the plant to the esophageal secretions ejected by the nematodes, and that these secretions are toxic to the plant.

In view of the above findings, a method is suggested of possibly alleviating the effects of this disease and allowing the affected plants to regain, at least in part, some of their former vigor. Infected boxwoods could be given fertilizers containing relatively heavy concentrations of potassium and low concentrations of sodium, nitrogen, and phosphorus. These materials could either be broadcast directly on the soil, applied to the soil as a liquid fertilizer, or injected into the plants. In theory, the restoration of the normal balance of mineral nutrients in the plant would promote a refunctioning of the normal plant metabolism, and new plant parts would eventually be produced. This might improve the appearance of the plants considerably but would not necessarily indicate that they were becoming immune to the effects of feeding by the nematodes. Rather, it would add to the life of the plants, and possibly insure their successful competition with the nematodes until some effective methods of control were devised.

SUMMARY

Mineral analyses for boron, calcium, magnesium, nitrogen, phosphorus, potassium, and sodium were conducted using stems, leaves, and roots of healthy and meadow nematode-infected dwarf English boxwoods, *Buxus sempervirens* var. *suffruticosa*. It was found that roots of infected plants contained higher levels of sodium and of nitrogen whereas the roots of healthy plants contained a higher level of potassium. Leaves of infected plants contained a higher level of phosphorus, while leaves of healthy plants contained a higher level of potassium.

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ENTOMOLOGY.—*A new genus and three new species of Microlepidoptera from California (Ethmiidae).*[1] J. F. Gates Clarke, Bureau of Entomology and Plant Quarantine.

The following new species and new genus are described to provide names to correspondents and to continue the arrangement and development of the National Collection.

Ethmia nadia, n. sp.

Figs. 1-1a

Alar expanse, 20–22 mm.

Labial palpus sooty black; basal segment heavily white scaled, second segment sparsely so and a narrow apical white annulus and the third segment white scaled above. Antenna sooty black with sparse white scaling on scape basally. Head sooty black with white scaling between the antennae and laterally. Thorax sordid white with four sooty-black spots placed one on each side, one anteriorly and one posteriorly; tegula sordid white with a black spot basally. Fore and hind wings blackish brown, cilia concolorous; forewing with a longitudinal white streak extending from base to end of cell where it forks, the scaling bordering the fork, black; the costal edge of the longitudinal streak narrowly edged with black, the dorsal portion overlaid with gray; at basal fifth, in the longitudinal streak, a black spot; around termen a series of indistinct black spots. Forelegs and midlegs blackish brown; hindlegs ocherous. Abdomen, except blackish brown first segment, orange-ocherous.

Male genitalia.—As figured. The posterior edge of gnathos with a strong comb of teeth; anterior portion with strongly sclerotized lateral teeth.

Female genitalia.—Female unknown.

Type.—U.S.N.M. no. 59367.

Type locality.—McCloud, Calif.

Remarks.—Described from the type ♂ and two ♂ paratypes, all from the same locality (June 5, 1935, E. C. Johnston). Both paratypes in Mr. Johnston's collection.

This species is nearest to *E. albistrigella* (Walsingham) but differs from it by the wider basal portion of the longitudinal streak of the forewing and by the presence of the black spot, in the white streak, at basal fifth. The anterior portion of the gnathos of *albistrigella* is studded with small teeth which are absent in *nadia.*

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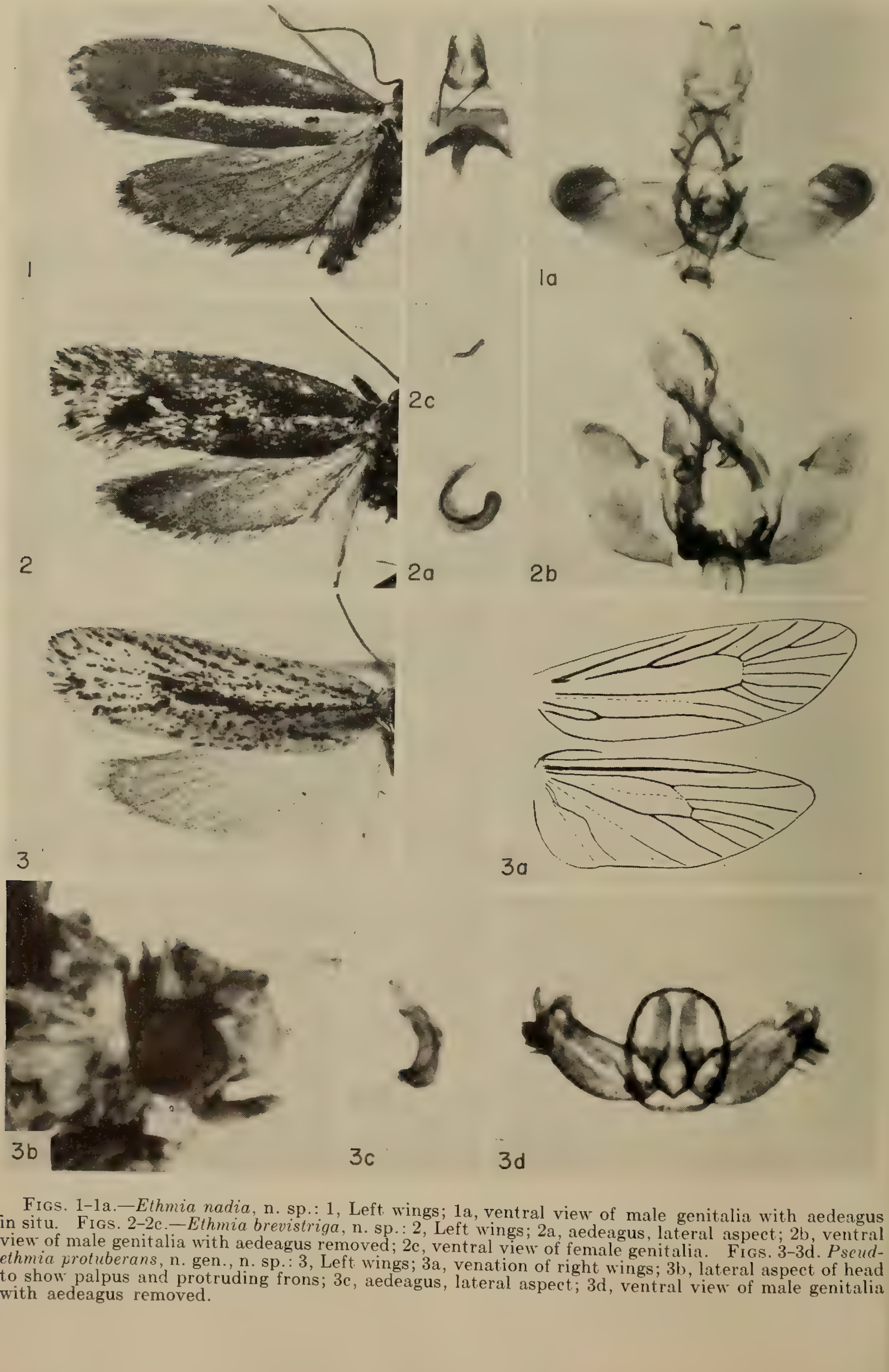
[1] Received March 14, 1950.



Figs. 1-1a.—*Ethmia nadia*, n. sp.: 1, Left wings; 1a, ventral view of male genitalia with aedeagus in situ. Figs. 2-2c.—*Ethmia brevistriga*, n. sp.: 2, Left wings; 2a, aedeagus, lateral aspect; 2b, ventral view of male genitalia with aedeagus removed; 2c, ventral view of female genitalia. Figs. 3-3d. *Pseudethmia protuberans*, n. gen., n. sp.: 3, Left wings; 3a, venation of right wings; 3b, lateral aspect of head to show palpus and protruding frons; 3c, aedeagus, lateral aspect; 3d, ventral view of male genitalia with aedeagus removed.

Ethmia brevistriga, n. sp.

Figs. 2-2c

Alar expanse, 13–14 mm.

Labial palpus blackish brown, basal segment heavily overlaid with white, second and third segments sparsely irrorate with white. Antenna, head, thorax, and forewing blackish brown; head white scaled posterolaterally; tegula white distally; forewing irrorate with white, heavily so before tornus and apically; from base of wing a very narrow, white streak extends along fold to about two-fifths; at the end of cell is a conspicuous white oblique oval spot; cilia fuscous mixed with white. Hindwing fuscous with a slight brassy hue; cilia whitish fuscous with a fuscous basal band. Legs blackish brown except posterior tibia and tarsus, which are whitish fuscous. Abdomen blackish brown, tipped posteriorly with ocherous white and sparsely irrorate with white beneath.

Male genitalia.—As figured. Anterior portion of gnathos consisting of two divergent lobes, excavated on their inner surfaces.

Female genitalia.—As figured. On right side of ductus bursae, just before ostium, there is a small evagination. Signum a narrow dentate plate.

Type.—U. S. N. M. no. 59368.

Type locality.—Bodega Bay, Calif.

Remarks.—Described from the type ♂ and two ♀ paratypes all from the same locality (May 2, 1937, E. C. Johnston). The type and one ♀ paratype are in the U. S. National Museum and one paratype is in Mr. Johnston's collection.

This species falls in the *albitogata* group but lacks the light hindwing.

Pseudethmia, n. gen.

Figs. 3-3d

Typus generis.—*Pseudethmia protuberans*, n. sp.

Head with posterior ridge, frons a prominent, rounded protuberance clothed with short, compact scales; dorsal surface of head smooth scaled except for small, lateral tufts of spreading scales above eye. Antenna simple, without pecten from scape. Labial palpus short, reaching slightly beyond lower edge of frons; second segment slightly longer than first; third segment about one-fourth the length of second, porrect. Tongue well developed.

Forewing elongate, ovate, costa nearly straight, 12 veins; 1b furcate, 1c strongly preserved, 2 from near angle; 7 and 8 stalked, both to costa; 11 from middle.

Hindwing slightly broader than forewing, 8 veins; 2 distant from 3, 3 and 4 connate or short stalked, 6 and 7 parallel basally, divergent distally; discocellulars inwardly oblique between 5 and 7.

Male genitalia.—Symmetrical; harpe roughly oval, clasper absent. Anellus with lateral processes. Uncus, socii and gnathos absent.

Female genitalia.—Female unknown.

This genus is nearest *Ethmia* Hübner but easily differentiated from it by the short palpus, protruding frons and absence of the uncus and gnathos.

Pseudethmia protuberans, n. sp.

Alar expanse, 18–21 mm.

Labial palpus sordid white, second segment with a blackish fuscous apical annulus. Antenna fuscous more or less overlaid with whitish basally. Head, thorax, and forewing sordid white irrorate with blackish fuscous; thorax with a narrow median fuscous stripe; from base of forewing along fold, thence to end of cell, an irregular blackish-fuscous longitudinal streak; cilia white with a narrow pale fuscous basal band. Hindwing pale whitish fuscous, slightly darker apically; cilia whitish with a narrow, pale fuscous basal band. Legs sordid white, tarsi faintly annulated with pale fuscous. Abdomen sordid ocherous white.

Male genitalia.—As figured. Note comb of modified setae from outer surface of cucullus.

Type.—U.S.N.M. no. 59369.

Type locality.—Dixieland, Imperial County, Calif. (March 1–15, 1922. O. C. Poling).

Remarks.—Described from the type ♂ and seven ♂ paratypes as follows: California, Dixieland, Imperial County, March and April dates, 5 ♂♂; Twentynine Palms (March 18, 1941, George Mansfield), 2 ♂♂.

Paratypes in U. S. National Museum, British Museum (Natural History) and the collection of J. W. Tilden, San Jose, Calif.

ZOOLOGY.—*Synonymy of some native American and introduced millipeds.*[1] H. F. LOOMIS, Coconut Grove, Fla.

The changes here proposed are the accumulation of several years of study and are presented for the most part in order to clarify obscure points in the classification of American diplopods. My thanks are due C. A. W. Jeekel, Zoologisch Museum, Amsterdam, Holland, who pointed out and suggested my publishing certain of the synonyms.

Prostemmiulus xenops, n. name

A new name for *P. heterops* Loomis (Bull. Mus. Comp. Zool. **80:** 29. 1936), preoccupied by *P. heteropus* Chamberlin (Occ. Pap. Mus. Univ. Michigan, no. 133: 15. 1923).

Genus **Alcimobolus** Loomis

Alcimobolus Loomis, Bull. Mus. Comp. Zool. **80:** 56. 1936.

Chamberlin has indicated (Proc. Acad. Nat. Sci. Philadelphia **99:** 44. 1947) that the genus *Alcimobolus* Loomis is synonymous with his *Cubocricus*, probably on the basis of the simple inner gonopods. Other characters of the gonopods, however, are strikingly different, not only from those of *Cubocricus* but from other related rhinocricids, and are amply sufficient to support generic separation. In *Cubocricus* the anterior plates do not exceed the median plate, but in *Alcimobolus* these plates are narrowed and carried far above the median plate. The posterior plates show an even greater departure from the more or less general form associated with most related genera by being higher and broadly rounded-truncate at the apex, near which the surface is slightly hispid; the latter condition, if not unique in the family, is certainly of rare occurrence.

Genus **Arinolus** Chamberlin

From 1922 to 1931 the writer collected extensively in southern Arizona in the hope of rediscovering three species of *Onychelus* that Cook described from there on females only (Proc. U. S. Nat. Mus. **40:** 157–159. 1911). No species of this genus was found, but two supposedly new species of a related new genus, later described by Chamberlin under the name *Arinolus*, were taken from a number of localities. Both of these species also have been described by Chamberlin, one, *A. torynophor*, as the type of his genus. Specimens of the other species, *A. hopinus*, collected by W. M. Wheeler at Tucson, November 21, 1910, and by the writer in the Baboquivari and Santa Rita Mountains, agree with Chamberlin's description of this species and also with Cook's description of *Onychelus hospes*, and it is thought that Cook was in error in referring his species to *Onychelus* and that now it should stand as follows:

Arinolus hospes (Cook)

Onychelus hospes Cook, Proc. U. S. Nat. Mus. **40:** 157. 1911.

Arinolus hopinus Chamberlin, Bull. Univ. Utah **31** (11): 12; pl. 2, fig. 16. 1941.

Study of three female specimens in the Museum of Comparative Zoology, collected in the Huachuca Mountains of Arizona by W. M. Wheeler in 1910, and of Cook's descriptions of *Onychelus dentatus* and *O. suturatus*, whose type locality is these mountains, also leads to the conclusion that but one species is involved and that it should be included in the genus *Arinolus* as its largest species.

Arinolus dentatus (Cook)

Onychelus dentatus Cook, Proc. U. S. Nat. Mus. **40:** 158. 1911.

Onychelus suturatus Cook, Proc. U. Nat. Mus. **40:** 159. 1911.

A great many Arizona specimens collected by the writer in the San Tan Mountains (near Sacaton), the Picacho Mountains (between Casa Grande and Tucson), the Superstition Mountains at Fish Creek (the type locality of *A. torynophor*), and between Superior and Miami, have 39 to 44 segments and are 25 to 38 mm long and 2.5 to 3.8 mm in diameter. Chamberlin's descriptions of both *A. torynophor* and *A. apachellus* fit these specimens, and his drawings do not seem to preclude the possibility that but a single species was represented, for the drawings of the inner ("posterior") gonopods are not comparable; that for *torynophor* does not show the important anterior face, and the anterior view of the complete gonopods of this species shows several more separate pieces than occur in any specimen of this family that the writer has seen or than are shown in Chamberlin's drawing of *apachellus*, which appears to have one extra piece at the lower left,

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[1] Received January 24, 1950.

the right side of the gonopod not having been illustrated. A drawing of the gonopods of a male from the San Tan Mountains is here included for comparison (Fig. 1).

Arinolus torynophor Chamberlin

Arinolus torynophor Chamberlin, Journ. Ent. and Zool. (Pomona College) **32:** 81. 1940.
Arinolus apachellus Chamberlin, Bull. Univ. Utah **31** (11): 10, pl. 2, figs. 12–14. 1941.

Genus **Pseudospirobolellus** Carl

Pseudospirobolellus Carl, Rev. Suisse Zool., **20:** 168; 1912.
Spirobolellus Attems, Mitt. Nat. Mus. Hamburg **24:** 131. 1907.
Azygobolus Loomis, Smithsonian Misc. Coll. **89** (14): 25. 1934.

Actual comparison of specimens may show that *A. tumidus* Loomis (Smithsonian Misc. Coll. 89 (14): 25. 1934) is a synonym of *P. bulbiferus* (Attems).

Genus **Chondromorpha** Silvestri

Chondromorpha Silvestri, Ann. Soc. Ent. Belg. **41:** 356. 1897.
Dasomus Chamberlin, Proc. Ent. Soc. Washington **43:** 34. 1941.
Xaymacia Loomis, Journ. Washington Acad. Sci. **38:** 187. 1948.

Chondromorpha kelaarti (Humbert)

Polydesmus kelaarti Humbert, Mem. Soc. Geneva **58:** 23, pl. 2, fig. 7. 1866.
Paradesmus kelaarti Pocock, Journ. Bombay Nat. Hist. Soc. **7:** 149, pl. 10, fig. 12. 1892.
Prionopeltis kelaarti Attems, Denkschr. Akad. Wiss. Wien **67:** 358, pl. 5, figs. 99–100. 1898.
Dasomus bicolor Chamberlin, Proc. Ent. Soc. Washington **43:** 34, fig. 4. 1941
Xaymacia granulata Loomis, Journ. Washington Acad. Sci. **38:** 187–188, figs. 3–6. 1949.

Chondrodesmus rodriguezi (Brolemann)

Leptodesmus rodriguezi Brolemann, Mem. Soc. Zool. France **13:** 103, figs. 43–46. 1900.
Dirhabdophallus rodriguezi Pocock, Biologia Centrali-Americana: 164. 1909.
Chondrodesmus nicaraguae Chamberlin, Ent. News **35:** 174, fig. 1924.

It is thought that *C. nicaraguae*, which may or may not have come from Nicaragua, although collected at New York City from a shipment of bananas from that country, actually is a synonym of Brolemann's *rodriguezi*. Pocock's figure of the gonopods of *C. spatulatus* (*loc. cit.:* pl. 12, fig. 6c. 1909) does not show the crest mentioned by Chamberlin in his description of *nicaraguae* but such a crest is shown in Pocock's figure for *C. granosus*, just above that of *C. spatulatus*. Brolemann's figure, cited above, shows the crest mentioned and figured by Chamberlin.

Genus **Docodesmus** Cook

Docodesmus Cook, Brandtia, fasc. 2: 5. 1896
Schizodira Loomis, Psyche **48:** 37–38. 1941.

An examination of Bollman's paratype female of *Stenonia maculata* (Proc. U. S. Nat. Mus. **11:** 336. 1888), recently found in the U. S. National Museum collection by R. L. Hoffman, settles several points that have long been in doubt. The family position of this milliped was correctly diagnosed as the Chytodesmidae, but the assumption that the species represented a new generic type, named *Schizodira*, was an error. Actually the species belongs to the genus *Docodesmus* Cook, although from Bollman's description its inclusion there could scarcely have been inferred. The "distinct notch" he noted between the third and fourth marginal area on each side of the first segment is very small (in the female at least) and might well escape notice, being no more conspicuous than the marginal irregularities of some other members of *Docodesmus*. Furthermore, Bollman's use of the word "crenulations," in referring to the shape of the outer margin of the lateral keels, is doubtful. "Indentation" would have been a more exact term, for the outer margins of segments 2–6, 8, 11, and 14 have two indentations setting off the three crenulations, and segments 7, 9, 10, 12, 13, and 15–19 have three indentations separating the four crenulations, as in the other species of *Docodesmus*.

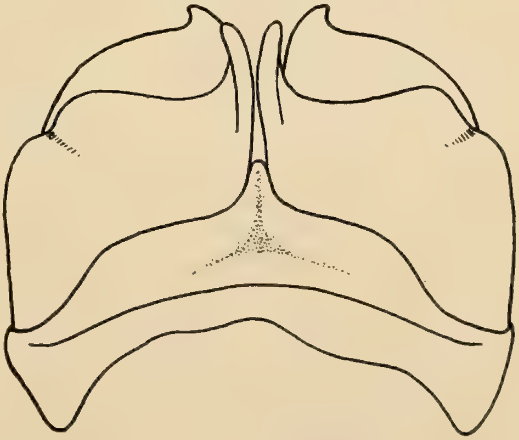

Fig. 1.—Gonopods (♂) of *Arinolus torynophor* Chamberlin, anterior view.

Docodesmus maculatus (Bollman)

Stenonia maculata Bollman, Proc. U. S. Nat. Mus. **11**: 336. 1888.
Platyrachus? maculatus Chamberlin, Bull. Mus. Comp. Zool. **62**: 216. 1918.
Schizodira maculata Loomis, Psyche **48**: 37–38. 1941.

Having finally located Bollman's species in the genus *Docodesmus*, we must reach a decision on the only other species of this genus known from Cuba. *Docodesmus cubensis* Loomis was founded on a mature female (Bull. Mus. Comp. Zool. **80**: 225–226, figs. 13, 14. 1937) when it was supposed to be the first Cuban species of the genus. It is closely allied to *maculatus* and eventually may be withdrawn into it after a study of more extensive material, but the present comparison appears to justify maintaining both species as valid. Outstanding differences of *maculatus* from *cubensis* are seen at the posterior end of the body, for the backwardly produced keels of segment 19 are small and acute, scarcely larger than any one of the four median tubercles of the posterior margin; between the keels of this segment there are six marginal tubercles (four in *cubensis*), with the outer tubercle on each side smaller than the median ones; the last segment is almost completely hidden by the preceding one, and the dorsum has two rounded median tubercles much smaller than the conic ones of *cubensis*.

Genus **Jeekelia**, n. name

A new name for *Melanodesmus* Loomis (Bull. Mus. Comp. Zool. **88**: 73. 1941), which is preoccupied by *Melanodesmus* Carl (Mem. Soc. Neuchatel. Sci. Nat. **5**: 908. 1914). *Jeekelia granulosa* Loomis is the only known species.

Genus **Prosopodesmus** Silvestri

Prosopodesmus Silvestri, Zool. Anz. **35**: 362. 1910.
Homodesmus Chamberlin, Bull. Mus. Comp. Zool. **62**: 222. 1918.

Prosopodesmus jacobsoni Silvestri

Prosopodesmus jacobsoni Silvestri, Zool. Anz. **35**: 362, figs. 6, 7. 1910.
Homodesmus parvus Chamberlin, Bull. Mus. Comp. Zool. **62**: 223. 1918.

This species appears to have been introduced from the Orient into the Western Hemisphere, where it now is found in Haiti, Puerto Rico, St. Eustatius, and Brazil.

ZOOLOGY.—*A new crawfish of the genus* Orconectes *from Louisiana.* (*Decapoda: Astacidae*).[1] GEORGE HENRY PENN, Tulane University. (Communicated by HERBERT FRIEDMANN.)

The new crawfish described here shows its closest affinities to *Orconectes clypeatus* (Hay) and thus represents the second species described which belongs to the subgenus *Faxonella* of Creaser. I am naming this new species in honor of the late George E. Beyer (1861–1926), first professor of zoology at Tulane University and a pioneer in exploring the zoology of Louisiana.

Orconectes (**Faxonella**) **beyeri**, n. sp.

Diagnosis.—Rostrum without lateral spines; rostrum broad, length averages three times its width. Thoracic region of carapace slightly less than one-third the total length of the carapace. Male with hooks on ischiopodites of third pereiopods only. First pleopod of form I male terminating in two rami: central projection a long sickle-shaped process bent mesially; mesial process much shorter, less than half the length of the central projection, bent in same direction; the two pleopods overlap each other in normal position. Annulus ventralis immovable, surface contours as in Fig. 7; sinus either dextral or sinistral.

Holotypic male, form I.—Body subovate, not depressed (Figs. 1, 2). Abdomen narrower than thorax. Width of carapace at widest point slightly greater than depth in same region.

Areola broad (3.1 times longer than width), with five or six punctations in narrowest part; cephalic portion of carapace about 2.3 times as long as areola; length of areola about 30 percent of total length of carapace.

Rostrum without lateral spines; widest at base, margins raised but only slightly thickened, converging at acumen. Upper surface shallowly concave; no median carina. Acumen of moderate length.

Postorbital ridges prominent, terminating cephalad in small acute corneous spines. Bran-

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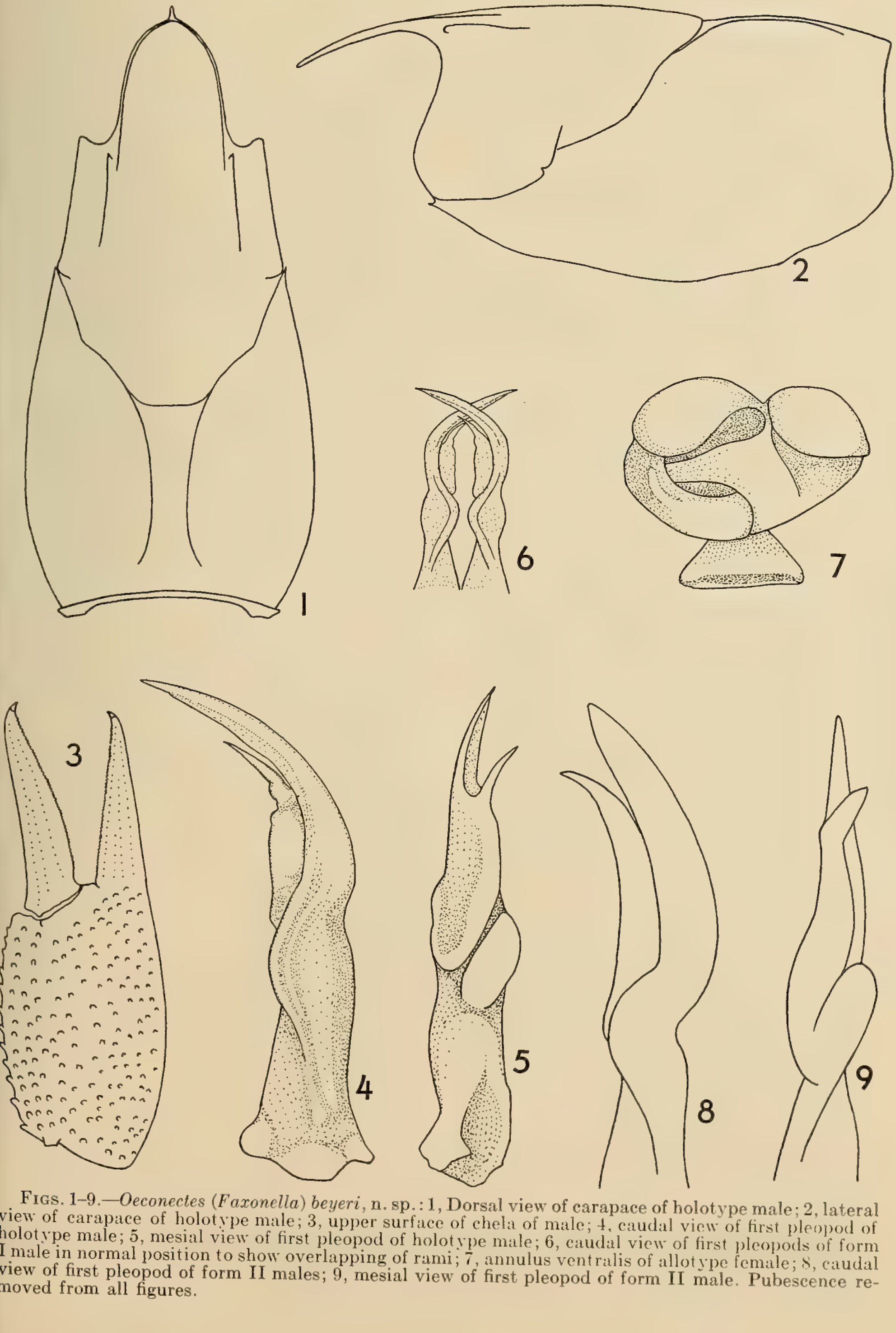
[1] Received January 23, 1950. Aided by a grant from the University Council on Research of the Tulane University of Louisiana.



Figs. 1–9.—*Oeconectes* (*Faxonella*) *beyeri*, n. sp.: 1, Dorsal view of carapace of holotype male; 2, lateral view of carapace of holotype male; 3, upper surface of chela of male; 4, caudal view of first pleopod of holotype male; 5, mesial view of first pleopod of holotype male; 6, caudal view of first pleopods of form I male in normal position to show overlapping of rami; 7, annulus ventralis of allotype female; 8, caudal view of first pleopod of form II males; 9, mesial view of first pleopod of form II male. Pubescence removed from all figures.

chiostegal spine small. Cephalic groove interrupted in vicinity of the very small cephalolateral spine on left side only; this spine absent on right side.

Cephalic region of telson with two spines in each caudolateral angle.

Antennules of usual form.

Antennae broken on holotype, nearly equal to total length of crawish in other specimens; of normal form.

Antennal scales extending beyond tip of rostrum; lateral margin straight, or nearly so, terminating in a small corneous spine; lamellar portion broad, the mesial margin describing a semicircle.

Chela somewhat depressed; palm inflated; inconspicuous punctations present over most of chela; surfaces of palm covered with small tubercles, largest near mesial margin (Fig. 3). Both fingers terminating in short corneous tips bent toward each other, the one on the movable finger slightly overhanging the tip of the immovable finger; no tubercles on opposable margins of fingers, these margins meeting fairly evenly for their entire lengths when fingers are closed.

First pleopod reaching middle of coxopodite of third pereiopod when abdomen is flexed. Tip terminating in two distinct rami (Figs. 4, 5) as follows: Central projection corneous, long, slender and sharply bent caudomesially ("sickle-shaped"); mesial process not corneous, much shorter, apex acute, also bent caudomesially beside the central projection; central projection over twice as long as mesial process. Pleopods in normal position lie with rami crossed as in *O. clypeatus* (Fig. 6).

Allotypic female.—Differs from the holotype male in the following respects: cephalolateral spine absent on both sides of carapace; tubercles of chela somewhat more conspicuous, larger; opposable margins of fingers not meeting for entire length, a gap being present near base; each finger with several large tubercles within proximal half of opposable margins.

Annulus ventralis subovate with the greatest length in the transverse axis; immovable (Fig. 7). Sinus originating slightly to the left of the midventral line in a trough near cephalic margin; from here sinus runs caudodextrad beneath an overhanging shelflike projection, then reappears to view before making an abrupt turn sinistrad nearly to midventral line, then turns sharply caudad to the posterior margin. Anterior margin of annulus raised on either side of the midventral line to form two rather conspicuous bulbous projections.

Paratypic male, form II.—Similar to holotype male in all respects except the following. Cephalolateral spines absent on both sides of carapace; areola not quite as wide, ratio of width into length equals 2.8. Hooks on ischiopodites of third pereiopods smaller, their length equal to less than half the diameter of the ischiopodite. First pair of pleopods without corneous tips on rami (Figs. 8, 9); mesial process longer and blunter, central projection blunt and thick; mesial process nearly three-fourths as long as central projection; pleopods barely overlapping each other in normal position.

Measurements.—Holotypic male: Carapace, height 6.3, width 6.5, length 13.7 mm; areola, width 1.3, length 4.1 mm; rostrum, width 1.6, length 3.2 mm; abdomen, length to tip of telson 15.0 mm; right chela, length of inner margin of palm 3.0, width of palm 2.2, length of outer margin of hand 8.0, length of dactyl 3.7 mm.

Allotypic female: Carapace, height 7.5, width 8.0, length 16.8 mm; areola, width 1.6, length 5.0 mm; rostrum, width 3.0, length 4.3 mm; abdomen, length to tip of telson 18.0 mm; right chela, length of inner margin of palm 3.3, width of palm 3.0, length of outer margin of hand 8.0, length of dactyl 3.7 mm.

Variation.—The 10 paratypes agree with the holotype and allotype in most respects, but certain minor variations should be noted. Areola: Ratio of width to length ranges from 2.7 to 3.6, with an average of 3.0 including the entire series of 12 specimens. One male, form II has small lateral spines present on the rostrum near the acumen, and has three caudolateral spines on the left side of the telson; another male, form II, has only a single caudolateral spine on the telson. The annulus ventralis is dextral in the allotype and one other female, sinistral in the other two females; the surface contour is the same in all the females except that one pair are mirror images of the other.

Type locality.—A roadside ditch on U. S. Route 84, 2 miles northeast of Naborton, De Soto Parish, La. This was an unshaded, mud-bottomed ditch in which the water was less than 12 inches deep, amber-colored and slightly turbid. Aquatic plants, including *Jussiaea* sp., were present, indicating the probability that the habitat is at least semipermanently wet.

Specimens examined.—A series of 12 from two localities in Louisiana as follows: De Soto Parish: 2 miles east Naborton, August 5, 1949, George H. Penn and Edward N. Lambremont (2 ♂ I, 2 ♂ II, 3 ♀); Natchitoches Parish: near Ajax, May 29, 1949, F. R. Cagle (4 ♂ II, 1 ♀).

Disposition of types.—The holotype male, form I (U.S.N.M. no. 90361), the allotype female (U.S.N.M. no. 90362), and one paratype male, form II (U.S.N.M. no. 90363), are deposited in the United States National Museum. Of the paratypes, two males, form II, and a female are deposited in the personal collection of Dr. Horton H. Hobbs, Jr., at the University of Virginia; and, one male, form I, one male, form II and one female from the type locality (TU 1440), and two males, form II (TU 1227), are retained in the Tulane University collections.

Relationships.—*Orconectes beyeri* clearly belongs to the subgenus *Faxonella* of *Orconectes* because of the small size of the mesial process in proportion to the central projection. *O. beyeri* is readily separated from the only other species in the subgenus, *O. clypeatus*, by the structure of the pleopods of the form I male, although both species have the same general structure of the rostrum and areola.

ORNITHOLOGY—*Two new genera of Furnariidae.*[1] James L. Peters, Museum of Comparative Zoölogy.

In preparing the manuscript for volume 7 of the *Check-list of birds of the world*, I have encountered two species among the Furnariidae that seem to require removal from their present generic assignments. These are *Asthenes maluroides* (d'Orbigny and Lafresnaye) and *Asthenes hellmayri* (Reiser).

Spartonoica, n. gen.

Diagnosis.—Similar to *Asthenes* Reichenbach, but tail much more graduated, the central pair of rectrices exceeding the outer pair by length of the wing, abruptly attenuated on their inner webs; upper and under tail coverts long and full, the latter concealing the lateral pair of rectrices. Similar also to *Leptasthenura* Reichenbach in degree of graduation of the tail, but bill longer, straighter, and less titlike.

Genotype.—*Synallaxis maluroides* d'Orbigny and Lafresnaye.

Remarks.—Though this species has been currently referred to *Asthenes*, the extremely graduated tail and abruptly attenuated rectrices distinguish *maluroides* from all the other species of *Asthenes* except *A. urubambensis* (Chapman), but in the latter the rectrices are gradually tapered, the tail coverts are not elongated, and the feet are relatively stouter. It appears more likely that *maluroides* may be more nearly related to *Leptasthenura*, but modified for a special type of habitat. The cinnamon-rufous crown certainly suggests a feature approached by several species of *Leptasthenura*, and likewise the absence of a guttural spot indicates no very close relationship to *Asthenes*, all of whose members except *A. maculicauda* (Berlepsch) possess this marking.

Gyalophylax, n. gen.

Diagnosis.—Similar to *Synallaxis* Vieillot, but tail composed of 12 rounded, instead of 10 pointed, rectrices; feet and legs much stouter; bill with culmen nearly straight and gonys ascending.

Genotype.—*Synallaxis hellmayri* Reiser.

Remarks.—This species is no doubt closely related to *Synallaxis*, as evidenced by the black gular patch and chestnut humeral patch, but is excluded by reason of its possession of 12 rectrices. Hellmayr placed it in *Asthenes*, but the very peculiarly shaped bill alone at once precludes it from any other existing genus among its near allies.

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[1] Received February 1, 1950.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

435TH MEETING OF BOARD OF MANAGERS

The 435th meeting of the Board of Managers, held in the Cosmos Club on February 20, 1950, was called to order at 8:10 P.M., by the President, F. B. Silsbee. Also present were: N. R. SMITH, H. S. RAPPLEYE, J. A. STEVENSON, F. C. KRACEK, W. N. FENTON, A. T. MCPHERSON, W. R. WEDEL, J. I. HOFFMAN, J. S. WILLIAMS, F. A. WEISS, W. A. DAYTON, E. W. PRICE, MARGARET PITTMAN, O. B. FRENCH. F. M. SETZLER, and, by invitation, R. G. BATES, J. L. SHERESHEFSKY, and F. J. HERMANN.

The following appointments were announced by the President:

Archivist (3-year term): JOHN A. STEVENSON.

Appointed members of Executive Committee: N. R. SMITH and W. N. FENTON.

Board of Editors of the Journal: F. C. KRACEK was designated Senior Editor; W. F. FOSHAG to replace ALAN STONE; C. W. SABROSKY as Associate Editor for a term of 3 years, representing the Entomological Society of Washington.

Committee on Membership: R. G. BATES (chairman), M. BERNARD, C. A. BETTS, W. BURBANK, R. C. DUNCAN, REGINA FLANNERY, A. B. GURNEY, E. H. KENNARD, C. L. LEFEBVRE, C. W. REES, D. C. SMITH, L. A. SPINDLER.

Committee on Meetings: F. M. DEFANDORF (chairman), F. O. COE, M. HARRIS, L. G. HENBEST, B. J. OLSON, F. B. SCHEETZ.

Committee on Monographs: To January 1953—R. W. IMLAY, P. W. OMAN.

Committee on Awards for Scientific Achievement (T. D. STEWART, general chairman): *For the Biological Sciences:* T. D. STEWART (chairman), ELOISE B. CRAM, A. O. FOSTER, E. L. LITTLE, H. H. MCKINNEY, J. S. WADE. *For the Engineering Sciences:* W. RAMBERG (chairman) L. W. CURRIER, R. C. DUNCAN, O. S. READING, H. W. WELLS. *For the Physical Sciences:* R. D. HUNTOON (chairman), W. BLUM, M. GOLDBERG, R. J. SEEGER, E. H. VESTINE.

Committee on Grants-in-Aid for Research: J. L. SHERESHEFSKY (chairman), C. J. CONNOLLY, L. E. YOCUM.

Committee on Policy and Planning: To January 1953—W. A. DAYTON, N. R. SMITH.

Committee on Encouragement of Science Talent: To January 1953—A. H. CLARK, F. L. MOHLER

Committee of Auditors: W. D. SUTCLIFFE (chairman), C. L. GAZIN, R. L. SANFORD.

Committee of Tellers: F. A. CHACE, JR. (chairman), H. F. STIMSON, E. H. WALKER.

The Secretary presented the following report of actions and recommendations taken by the Executive Committee:

The meeting was called to order by the President, F. B. SILSBEE, at 5:50 P.M., at the Cosmos Club. Present were: N. R. SMITH, W. N. FENTON, H. S. RAPPLEYE, and F. M. SETZLER.

The Treasurer, H. S. RAPPLEYE, presented for discussion a budget for 1950. This budget, presented below, was finally approved, with the recommendation that it be presented to the Board of Managers.

RECEIPTS

	1949	*(Estimated) 1950*
Dues	$3,856.75	$3,800.00
Subscriptions	1,743.50	1,750.00
Interest & dividends	975.00	1,000.00
Sale of publications	987.61	250.00
	$7,562.86[1]	$6,800.00[2]

DISBURSEMENTS

	1949	*(Estimated) 1950*
Journal and Journal Office	$6,250.00	$6,350.00
Secretary	549.58	550.00
Treasurer	208.64	300.00
Subscription Manager and Custodian of Publications	37.34	50.00
Meetings Committee	345.13	500.00
Membership Committee	16.51	20.00
Science Fair	100.00	100.00
Science Calendar	—	10.00
	$7,507.20	$7,880.00

Operating deficit for 1950	$1,080.00
Second payment on 40-year index	500.00
Fireproof records cabinet	275.00
Estimated decrease in net worth	$1,855.00

[1] December reprints estimated.
[2] Plus charges to authors.

The Treasurer presented a communication from W. F. WILLOUGHBY, president of the Washington Sanitary Improvement Co., indicating a proposal made by the Colonial Investment Co. to purchase 95,000 shares of the Washington Sanitary Improvement Co. stock. The understanding was that if the Colonial Investment Co. could obtain the above-mentioned shares by 2:00 P.M. on March 15, 1950, they would be willing to purchase these shares for $32 per share. The Academy now holds 818 shares of Washington Sanitary Improvement Co. stock. The Executive Committee moved that the following recommendation be presented to the Board: "That the Treasurer of the Washington Academy of Sciences be authorized to deposit 818 shares of Washington Sanitary Improvement Company stock with the Washington Loan and Trust Company in accordance with the provisions outlined in a letter of January 27, 1950, from W. F. Willoughby, President of the Washington Sanitary Improvement Company, to the stockholders."

The meeting was adjourned at 7:56 P.M.

F. M. SETZLER, *Secretary.*

It was unanimously voted by the Board that the budget as presented by the Treasurer be approved.

Separate action was taken by the Board on the recommendation by the Executive Committee dealing with the sale of 818 shares of Washington Sanitary Improvement Company stock. After some discussion it was unanimously voted to approve the recommendation for the sale of these shares.

The President announced that at the next meeting of the Academy, on March 16, the annual Awards as well as the Certificates of Merit would be presented to the recipients.

The Committee on Membership presented the names of 18 nominees for resident and one for nonresident membership.

The Chairman of the Committee on Monographs recommended that the Custodian of Publications insert advertisements in various ornithological journals with regard to the sale of Friedmann's "The Parasitic Cuckoos of Africa," the Academy's Monograph No. 1.

The Chairman of the Committee on Encouragement of Science Talent presented the following report, which was approved by the Board:

> The Committee on Encouragement of Science Talent has examined the records of the 28 local contestants in the National Science Talent Search conducted by the Westinghouse Educational Foundation and Science Service.
>
> The board of judges of the national search selected three honorable mention contestants from this group. In compliance with the terms of our agreement with Science Service these three contestants have been named as local winners. The committee has reviewed the records of these contestants and agrees that they are worthy of being named among the local winners.
>
> One contestant, Miles Davis, son of Watson Davis, director of Science Service, would have been selected as a national search winner but was disqualified by reason of his relation through his father to one of the sponsoring agencies. The committee has reviewed the record of this contestant and unanimously agrees that his record justifies selection as a local winner.
>
> The Committee reviewed the records of those local contestants not selected on a national basis and concluded that two additional local contestants had demonstrated science talent worthy of recognition by the Academy.
>
> The Committee, as a result of its study, recommends the following persons to receive the Certificate of Merit of the Academy:
>
> *Miles Davis* (age 16, Central High School), for science talent demonstrated by his studies of the accuracy of visual variable-star observations.
>
> *William Edward Drissel* (age 16, Gonzaga High School), for science talent demonstrated by his study of optical instruments.
>
> *Phil Stratford Work* (age 17, Western High School), for science talent demonstrated by his study of the staining of fungus media.
>
> *Patricia Morse Federico* (age 16, Woodrow Wilson High School), for science talent demonstrated by her study of cancer.
>
> *Donald Jason Byers* (age 17, Woodrow Wilson High School), for science talent demonstrated by his tests in a small scale wind tunnel.
>
> *Paul Douglas Sheats* (age 17, Woodrow Wilson High School), for science talent demonstrated by his analysis of the erosional mechanics of a small stream.
>
> The Committee further recommends that the Secretary of the Academy be authorized to furnish a letter of recommendation for each of the above to the colleges or universities of their choice, indicating that they are recipients of the Academy's Certificate of Merit and that they are considered worthy of consideration for scholarship awards by the college or university.
>
> It is recommended finally that suitable public notice of these selections be disseminated. Draft of an appropriate news release for local newspapers is attached.
>
> Martin A. Mason, *Chairman.*

Dr. Mason also suggested that this year the Science Fair sponsored by the Academy issue an identification card to be presented to the winners. This took the form of a motion that the Academy provide certificates in recognition of the Science Fair Winners, which was approved by the Board. He also reported that arrangements have been made for the Science Fair to be held May 15–19, 1950, in the Auditorium of the Department of Commerce.

Six nominees were elected to membership in the Academy.

The Secretary reported the following deaths: George S. Rice, formerly of the Bureau of Mines, on January 3, 1950 (elected December 22, 1924; on retired list December 31, 1937); Clarence A. Reed, Plant Industry Station, Beltsville, Md., on January 14, 1950 (elected May 13, 1946).

The Secretary also reported the nominations for Vice-Presidents of the Academy by two of the Affiliated Societies:

Medical Society of the District of Columbia....	Frederick O. Coe
Washington Section, American Society of Mechanical Engineers....	Richard S. Dill

The nominees were unanimously elected.

The Senior Editor of the Journal urged that more papers be submitted for publication in the Journal.

A discussion was held with regard to the creation of a central office to handle the various duties, such as the Secretary and Treasurer offices for the Academy and the Affiliated Societies. The Board approved a motion that a committee be appointed by the President to explore the possibility of the creation of such a central office.

The meeting was adjourned at 10 P. M.

436th Meeting of Board of Managers

The 436th meeting of the Board of Managers, held in the Cosmos Club on March 20, 1950, was called to order at 8:10 P. M., by the President, F. B. Silsbee. Also present were: N. R. Smith, H. S. Rappleye, J. A. Stevenson, F. C. Kracek, F. M. Defandorf, W. R. Wedel, C. F. W. Muesebeck, C. A. Betts, R. S. Dill, E. W. Price, Margaret Pittman, F. M. Setzler, and, by invitation, R. G. Bates and L. W. Parr.

The following appointments were announced by the President: H. L. Curtis (Chairman), Norman Bekkedahl, and Howard S. Rappleye to serve as a committee to examine the desirability of establishing a central secretarial office to be used jointly by the Academy and a number of its affiliated societies.

The Committee on Membership presented the names of 17 nominees for resident and 1 for nonresident membership.

Nineteen individuals whose names had formerly been proposed were elected to membership.

The Secretary reported the following deaths: Henri F. Pittier, of Caracas, Venezuela, on January 27, 1950 (elected May 17, 1915; elected to honorary membership June 9,1939); Carlos de la Torre, of Havana, Cuba, on February 19, 1950 (elected to honorary membership June 9, 1939).

The Secretary read a letter from Charles Weir, Jr., 1949 recipient of the Academy's Certificate of Merit, describing his scholastic experiences at the University of California at Los Angeles.

The Treasurer reported the purchase of a fireproof vault for his files, as well as a typewriter.

The Archivist, J. A. Stevenson, reported the transfer of the Academy's archival material from the previous Archivist, Nathan R. Smith, and indicated that a considerable reorganization of these records is now being made.

The meeting was adjourned at 9 P.M.

F. M. Setzler, *Secretary*

ANTHROPOLOGICAL SOCIETY

The Anthropological Society of Washington at its annual meeting on January 24, 1950, elected the following officers: President, W. Montague Cobb (reelected); Vice President, Waldo R. Wedel; Secretary, William H. Gilbert, Jr.; Treasurer, Margaret C. Blaker (reelected); Councilors to the Board of Managers, Cornelius J. Connolly, John M. Corbett, Carl F. Miller (reelected), Mark Hanna Watkins, Eugene C. Worman, Jr. (reelected); Representative to the Washington Academy of Sciences, Waldo R. Wedel.

A report of the membership and activities of the Society since the last annual meeting follows:

Life members, 1; Active members, 78; Associate members, 18; Total, 97. This represents an increase of 10 since last year.

The members elected during the year were: Active members: Dr. Sidney Adams, Carroll M. Brodsky, John M. Corbett, John H. Cox, Miss Elizabeth DeGroat, Miss Irene Diggs, Dr. David C. Graham, Dr. Eleanor P. Hunt, John T. McGee, John Purcell, Anders Tejler, Dr. Eugene C. Worman, Jr.; Associate members: Ralph Solecki, C. Malcolm Watkins.

The Society records its deep sense of loss at the deaths of Father John M. Cooper, a past-president of the Society and member since 1922, and Dr. Riley D. Moore, member since 1922.

The report of the Treasurer follows:

Income:		
A.S.W. dues collected....	$95.00	
Dues from member, status in doubt..............	6.00	
Interest, Perpetual Building Association........	60.14	
Dividends, Washington Sanitary Improvement Co..................	21.00	
Dividends, Washington Sanitary Housing Co.	12.00	
Interest, U. S. Savings Bonds...............	12.50	
Sale of Old Series *Anthropologists*..............	6.00	
		$212.64
Cash in bank............		295.51
		$508.15

Expenditures:		
A.A.A. dues paid for Secretary, Treasurer and 1 life member......	15.00	
Speakers' expenses.......	116.34	
Incidental meeting expenses...............	16.75	
Refund to member.......	5.00	
Printing and mailing notices...............	46.54	
Flowers for funerals......	18.23	
Secretary's expenses.....	32.25	
Treasurer's expenses.....	4.73	
		225.84
Balance in bank......		$282.31
Assets:		
Funds invested in Perpetual Building Assn.	$2,000.00	
42 shares Washington Sanitary Improvement Co. (par value $10 per share).............	420.00	
2 shares Washington Sanitary Housing Co. (par value $100 per share)...	200.00	
U. S. Savings Bond, ser. G	500.00	
Cash in bank............	282.31	
Total as of December 31, 1949............		$3,402.31
Total as of December 31, 1948...........		3,415.51
Decrease...........		13.20
Less Bills outstanding:		
To A.A.A. (subscription to *American Anthropologist*, 1950)............	$5.00	
To be allocated on behalf of member, status in doubt................	6.00	
		11.00
Net decrease........		24.20

All regular meetings were held at the U. S. National Museum. The programs for the first part of the year were arranged by DR. GORDON R. WILLEY; for the second part by DR. EUGENE C. WORMAN, JR.

Titles of the papers presented before the regular meetings of the Society were:

January 26, 1949, A. I. HALLOWELL, *Cultural variables and spatial orientation.*

February 15, 1949, HARRY TSCHOPIK, *Chucuito, an Aymara village in Southern Peru* (motion pictures and records).

March 15, 1949, JOHN H. COX, *Aspects of Early Yangtze Valley culture revealed by recent excavations at Ch'ang-Sha* (slides).

April 19, 1949, C. S. COON, *Recent anthropological reconnaissance in Iraq and Iran* (slides).

May 17, 1949, A. H. SCHULTZ, *The evolution of human development* (slides).

October 18, 1949, CARL SCHUSTER, *A series of significant correspondences between Old and New World design* (slides).

November 15, 1949, P. O. PEDERSEN, *Ecological and racial aspects of Eskimo dentition, based upon studies in East and West Greenland* (motion pictures).

The Society decided on a general plan to cut down errors in the mailing of notices. The Secretary was empowered to negotiate with the American Anthropological Association in the sale of Old and New Series *Anthropologists* now in the Society's possession. Certain stipulations as to price and other conditions were made. The President was instructed to appoint one member to help the Secretary in these matters. It was also decided that the President should appoint a committee to make recommendations on the many necessary changes in the bylaws.

MARSHALL T. NEWMAN, *Secretary.*

Obituaries

ORATOR FULLER COOK, agriculturist, botanist, and zoologist, was born at Clyde, N. Y., on May 28, 1867. He died in his home at Lanham, Md., on April 23, 1949, following a short and supposedly minor illness. His immediate surviving relatives are a son, Robert C. Cook, editor of the *Journal of Heredity*, and two daughters, Mrs. Elizabeth Upton, of Lanham, Md., and Mrs. Helen Moore Newman, of Chicago, Ill.

Cook was graduated from Syracuse University in 1890 and continued there as instructor for one year. During this time he studied and worked with Prof. L. M. Underwood, and the many interests in botany and zoology then aroused remained active throughout his life. In 1930 the University honored him with the D. Sc. degree.

He was a member of the American Association for the Advancement of Science; the American

Genetic Association; the Botanical Society of America; the Association of American Geographers; the Washington Academy of Sciences; and the Anthropological, Biological, Botanical, and Entomological Societies of Washington; and was honorary assistant curator of cryptogams and custodian of Myriapoda in the U. S. National Museum.

From 1891 to 1898 he was employed as special agent of the New York State Colonization Society and spent much of the time in Liberia, making three voyages there, to prepare for repatriation of the American Negro. In 1898 he entered the U. S. Department of Agriculture, and here he spent the remainder of his professional career, becoming a member of a group of young scientists among whom were such men as L. J. Briggs, G. N. Collins, F. V. Coville, David Fairchild, L. O. Howard, T. H. Kearney, Theobold Smith, W. T. Swingle, and M. B. Waite, to name but a few, whose work was to have a tremendous and imperishable effect on agriculture.

For several years he was in charge of seed and plant introduction and of tropical agricultural investigations of the Department of Agriculture, following which he was made head of an office that bore several titles, all of them covering the fields of rubber, cotton, and tropical crop plant investigations; he remained in this capacity until 1934 when he was transferred to the Division of Plant Exploration and Introduction. Retirement came in 1937 at the age of 70, but this did not mean cessation of work, for he continued to appear at his office with almost as great regularity as had been his wont.

Few men of his time had wider interests or more profound knowledge of many biological subjects, and these led to extensive travel throughout the Central American countries, Puerto Rico, Haiti, Peru, Egypt, Liberia, Persia, and China, as well as the cotton-growing regions of the United States. He became an authority on modern and pre-Columbian tropical agriculture, and his researches did much to solve the questions of how the Inca, Maya, and related peoples maintained themselves, and of the origins of certain tropical plants. At an early date he foresaw what was thought to be the impossible cutting off of the supplies of rubber from the Orient, and was a strong and ever-active proponent of establishing high-yielding varieties of the Para rubber tree in plantation form in the American Tropics and of developing production from other tropical and subtropical species of this hemisphere.

Although professing to have less natural interest in the cotton-growing industry than in his more tropical researches among plants and animals, nevertheless he gave to it by far the largest portion of his time, and his greatest contributions to the economy of the country were made in this field. His work with cotton began at the time when the cotton-boll weevil was beginning to make its entry into this country from across the Rio Grande. Through studies relating to the insect, he eventually changed the generally accepted methods of wide-spaced plantings to very much closer spacings in the row that produced crops before the weevils appeared in large number, lessened the number of pickings, and effected other economies. New and better varieties of cotton, some of which are widely planted today, were introduced or bred from those already here. The "one-variety cotton community" was an important improvement over the indiscriminate planting of many varieties, assuring continuous supplies of pure planting seed, better ginning and a less variable staple length, for which more uniform prices are paid.

Dr. Cook was a tireless worker and remarkably keen observer, never without a sheaf of small note paper on which observations and ideas were recorded, later to be filed under their proper headings. The writer does not recall of his ever taking a vacation for change of scene and relief from work. This was obtained, instead, by intermissions of varying length during which an entirely different subject would be the center of attention. From such digressions came many systematic and other studies on myriapods and palms, in both of which groups he was an international authority. His writings also relate to human colonization; sociology; evolution; genetics; biological nomenclature; horticultural aspects of miscellaneous tropical economic plants; the botany of the lower plants, the myxomycetes and mosses; and to structural characteristics, diversities, habits, and classification of many of the higher plants and of numerous arthropods. These literary labors total almost 400 articles and books.

Dr. Cook lived simply and with an unbounded love for the country. He disliked the restraint and artificiality of city life and shunned large crowds and social gatherings. One of his greatest pleasures was the collecting of old and rare books, which he indulged in on all his journeys and at home, gathering many treasures from which he drew ideas and references for his writings. He also was an ardent collector of the palms and myriapods on which he worked. Endowed with a strong artistic sense, which manifested itself in many ways, on a trip to China in 1919 he first saw and admired the curious gnarled root and branch formations the cultured Chinese gathered, often enhanced in beauty by judicious carving, shaping, or polishing, and mounted as art objects under the name of "Frame Mountains." From then on he produced many of these ornamental pieces, working on them while his mind was occupied with thoughts of the subject on which he was then writing, the two projects progressing together to his satisfaction.

Dr. Cook held the friendship and esteem of a large number of people who mourn his passing with the knowledge that the world has lost one of its great scientists and scholars.

H. F. Loomis.

Perley G. Nutting.—In the death of Dr. Perley Gilman Nutting, on August 8, 1949, the science of physics has lost one of its pioneers in the physics of light, the Geological Survey has lost one of its able and active investigators in the physics and chemistry of clays, and many of us have lost a dear friend.

Nutting was born at Randolph, Wis., on August 22, 1873, son of Charles and Cordelia (Gilman) Nutting. He was of early American pioneering stock, a descendant of John Nutting who left Nottinghamshire, England, in the company of John Winthrop, and settled in Groton, Mass., in 1632.

He received his bachelor's degree from Stanford University in 1897 and his master's degree a year later from the University of California. He spent a year at Göttingen, Germany, as Whiting fellow of the University of California, and with another fellowship studied at Cornell, where he received his doctor's degree in 1903.

He started his professional career in July 1903 at the National Bureau of Standards, where he began his work in optical research. Here he grew to have an intense and devoted interest in the fundamental physical problems of illumination and vision. His contributions to the understanding of the phenomena of light brought him a world-wide reputation and led to his occupying a high professional position among American physicists. While at the Bureau of Standards he made determinations, important in spectroscopy, of the relation between the internal energy of the light source and the line intensity; in visual optics, he determined and formulated the relation between light sensation and the radiant source of light. He invented a colorimeter and a spectrophotometer. His spectrophotometer was the first instrument to measure color in absolute terms; i.e., as intensities of different wave lengths of light, rather than by comparison with arbitrary reference standards. The Hilger-Nutting spectrophotometer is today a popular instrument. He designed a high precision lens testing bench, which became standard equipment in making and testing lenses. In 1912 he published a summary of this work in his *Outlines of applied optics*, a very useful and practical textbook.

The value of his work led to his being called to important positions with commercial organizations. In 1912 he went to the Eastman Kodak Co. to help Dr. C. E. K. Mees organize a new research laboratory in photography, assuming charge of the physics section. From 1916 to 1920 he organized and was the director of the research laboratory of the Westinghouse Electric and Manufacturing Co., for which he built up a staff of more than 90 research scientists. In 1920 he became a practicing consultant, largely in the field of lighting equipment for motion-picture studios. He developed a 100,000-candle-power incandescent light, the largest made up to that time, for use in color photography.

Having spent over 20 years in study of the theory of light and its practical application, a field of activity that brought him renown and high professional position, Dr. Nutting then turned his busy and inquiring mind to other fields of science. In 1924 he spent a year as consulting physicist at the Fixed Nitrogen Research Laboratory in Washington, and in 1925 he went to the Geological Survey, where he spent the last eighteen years of his professional life, devoting himself to the examination of the clay minerals and their practical application. His many papers on clays have been widely read. One of the diagnostic properties of clays he studied extensively and carefully was dehydration at various temperatures. His method of measuring the bleaching capacity of activated clays has been much used. His success in this work was the result of his imagination and flexibility of mind, his unwillingness to accept any task or line of study as an impossible one for him, and his intense devotion to the study of clay minerals. This devotion continued after his retirement in August 1943, in work with clays at home, frequent trips into the field to gather new specimens, and in his many visits to the Survey to talk with his former associates. The circumstances of his death are indicative of his devotion to the study of clays; he had just left the Survey and was on the way to the National Museum, perhaps to obtain additional specimens or to consult with the staff there on matters pertaining to clays.

Dr. Nutting had the distinction of being a founder and the first president (1917–19) of the Optical Society of America. He also belonged to the Geological Society of Washington, the American Physical Society, the American Astronomical Society, the British Optical Society, the Franklin Institute, the American Chemical Society, and the Washington Academy of Sciences. The diversity of the fields of these scientific organizations reveals his breadth of knowledge and interest.

Dr. Nutting was married twice. His first marriage was on October 12, 1906, to Edith Eva, daughter of Capt. George Lightfoot, Royal Navy. She died in 1924, leaving four sons: Ian Fitzallen, Kelvin Lightfoot, Edward Volney, and Perley Gilman Nutting, Jr. His second marriage was on April 7, 1928, to Julia Elizabeth, daughter of Samuel S. Stouffer, of Sharpsburg, Md.

His many friends on the Survey and in the Geological Society of Washington mourn the passing of this great physicist.[1]

Rollin E. Stevens.

Charles J. Clifford, mathematician, U. S. Coast and Geodetic Survey, died during the evening of December 21, 1949, at George Washington University Hospital in Washington, D. C., after an illness that had kept him away from his desk for less than three months. He was buried in Arlington National Cemetery.

Clifford was born in Denver, Colo., on August 28, 1894, the son of James and Caroline Drummond (Veale) Clifford. He graduated from Union High School No. 1 of Adams County, Colo., in June 1914. He was variously employed until he entered the military service on September 20, 1917. Discharged on account of physical disability on December 19, 1917, he returned to his home. He became a rural mail carrier on March 1, 1918, and worked out of Derby, Colo., until September 15, 1920, when he resigned in order to attend the University of Colorado. Clifford received his B.S. degree in electrical engineering in June 1924 and, after two minor engineering assignments entered the Federal service as a junior mathematician on July 25, 1925, being assigned to the section of leveling of the Coast and Geodetic Survey.

During the nearly 25 years of his service with the Survey, Clifford progressed through the grades of assistant and associate mathematician, attaining the rating of mathematician in 1941. During the most of this period Mr. Clifford was concerned with the processing of the field data of precision leveling and in the interpretation of the results, especially when repeat leveling revealed earth movement.

Clifford assisted in the special adjustment of the first-order level net of the United States in 1927. Again, in 1929, he worked on the special and general adjustments of the combined level nets of the United States and Canada. In 1940 and 1941 he undertook a complete study and readjustment of all the first-order leveling, both by the Mississippi River Commission and the Coast and Geodetic Survey, in the alluvial valley of the Mississippi River.

For a considerable period of time Mr. Clifford's work has included the preparation of material for the *Bibliography of geodesy* for the International Union of Geodesy and Geophysics. He also attended the meetings of that organization in Oslo in 1948.

His memberships in various organizations included the American Association for the Advancement of Science, the Polar Society, and the American Geophysical Union. He was elected to membership in the Washington Academy of Sciences on January 14, 1946.

Clifford was a member and past commander of Cissel-Saxon Post, American Legion, at Silver Spring, Md., and also a member of the Maryland State Guard.

His marriage to Lena Marie Andres took place on September 18, 1918. He is survived by his widow; two sons, Eugene and Charles; his mother; his brother, Joseph M. Clifford; a half-brother, William M. Garrison, and a half sister, Mrs. Jesse Collins.

Howard S. Rappleye.

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[1] Communicated to the Geological Society of Washington on February 8, 1950.

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JOURNAL

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Journal of the Washington Academy of Sciences

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JOURNAL
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ENTOMOLOGY.—*The genetics laboratory mite* Histiostoma laboratorium, *n.sp.* (*Anoetidae*).[1]

Roscoe D. Hughes, Medical College of Virginia, Richmond, Va. (Communicated by Robert C. Cook.)

For years mites that thrive on *Drosophila* culture media, such as banana-agar or corn-meal-molasses-agar, have been serious pests in genetics laboratories. Of the several known forms that can successfully be cultured on these media, at least two families and several genera are represented. On the basis of observations made to date, however, the form described below is believed to be by far the commonest pest. That this is so is readily understood when we consider that this species has a short life cycle and a very effective migratory phase. The hypopus is resistant to desiccation, can crawl long distances in the laboratory, and can be dispersed over greater areas by becoming attached by suckers to *Drosophila* and other insects.

Although this species has been observed innumerable times, it appears not to have been previously described. The possible exception is Stanley G. Stolpe's description of *Histiostoma genetica* (*The life cycle of the tyroglyphid mites infesting cultures of* Drosophila melanogaster. Anat. Rec. **72**: (Suppl.: 133–134. 1938).His paper contains no illustrations and is so lacking in pertinent details that it is impossible to use it as a basis for establishing a new species. Studies are now in progress on the biology and cytogenetics of this new species and related forms.

Acknowledgments.—My thanks are due to Miss Dorothy Booth for her assistance in preparation of the finished drawings, to Dr. H. H. J. Nesbitt for his kindness in reading the manuscript, and especially to Miss Caroline O. Goode for her generous assistance in all phases of this study.

Histiostoma laboratorium, n. sp.

Female (Figs. 1, 2, 5).—Average length of adult gravid females 0.46 mm, average width 0.31 mm. Gravid females over six days old from uncrowded cultures varied considerably in length and width. Length varied from 0.40 mm to 0.51 mm; width from 0.26 mm to 0.39 mm. Measurements refer to total length and width of body including gnathosoma but are exclusive of legs and setae extending beyond the body margins. Color of body whitish, semitransparent, and finely granular. The body of gravid females is rotund with sides gradually tapering anteriorly; nongravid females with sides of body more or less parallel. On the ventral surface the ring or sole-shaped structures characteristic of the family Anoetidae are conspicuous. The anterior pair is more or less sole-shaped and is located anteriad and slightly mesiad of trochanter III. The posterior pair is triangular to ring-shaped and lies in a position more mesiad than the anterior pair and on a line connecting trochanters IV. The anal slit is also conspicuous and lies in a median position somewhat near the posterior tip of the body. The vulva, very difficult to see, is a wide, transverse opening, slightly convex on the anterior edge, with the lateral margins almost in contact with the sole-shaped structures. The anterior lip is marked by a slight thickening of chitin. Two small chitinous processes from this lip seem to project posteriorly into the orifice, which can most easily be demonstrated by probing with a fine needle. The ventral body surface bears six pairs of very small setae located as follows: first pair, slightly above a line connecting trochanters II, median in position; second pair, slightly posteriad of the lateral margins of vulva; third pair, on a line connecting trochanters III and directly beneath the anterior sole-shaped structures; fourth pair, beneath and slightly lat-

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[1] Received March 20, 1950.

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erad of the posterior pair of ring-shaped structures; fifth pair, close to the anterior end of the anal slit; sixth pair, slightly below the posterior end of anal slit and more lateral than the fifth pair. All these setae are very fine but spinelike. The second and sixth pairs are hardly more than minute bristles and consequently seen with difficulty. In addition to these small setae there is a pair of posterior ventral submarginal setae, which are similar to the typical setae on the dorsal surface but somewhat shorter and thinner at the base. Also there is a pair of long anterior submarginal setae between legs II and III. Since the body is semitransparent the large eggs are easily seen. Fig. 1 shows a female with three eggs. As many as five or more well-formed eggs can be dissected from a fully gravid female. Ventrally the coxae together with the apodemata form conspicuous, ramifying structures but only their main outlines are shown in Fig. 1.

Dorsally an almost invisible sulcus posteriad of legs II can be seen. In the anterior or cervical region of the propodosoma faintly visible sclerotic thickenings form a characteristic mosaic pattern. In the posterior portion of the propodosoma a different type of pattern, consisting of rectanglelike structures with the long axes parallel to the main axis of the body, is sometimes but more faintly seen than the mosaic pattern in the anterior region. Neither of these sclerotic patterns is shown in Fig. 2. Presumably together they form the so-called propodosomal shield frequently visible on other species. A pair of well-defined excretory organs lie in a lateral position posteriad of legs IV. The small excretory pore is found on a slight elevation, beneath which a rather large transparent colorless vesicle may be seen. On a level with the excretory organs and in the midline, the small but distinct poer of the bursa copulatrix is visible. Eight setae are found dorsally on the propodosoma: a pair of minute bristlelike rostral setae at the anterolateral corners, sometimes apparently overhanging the margin; a small pair of cervical setae; an inner and outer pair of propodosomatic setae, which are long and tapering. On the hysterosoma are five pairs of more or less median setae: first pair, just posteriad of the sulcus; second pair, one on each side of the bursa copulatrix; third, fourth, and fifth pairs placed progressively more posteriad with the fifth, or most posterior pair, marginal in position. There are six lateral setae on each side of the dorsum: two very close together in the humeral position and on same level with the ventral anterior submarginal seta; one slightly posteriad of leg III; one laterad of the excretory organ; one behind preceding; and one posterior marginal seta. Except for the three median pairs of setae on the propodosoma, the relative sizes of which are shown in Fig. 2, all the dorsal setae are approximately of the same length. These setae appear very much like the lighted end of a candle. They arise from short cylindrical protuberances, have narrow bases, which increase in diameter in the proximal portion of the setae, and taper abruptly to long fine points.

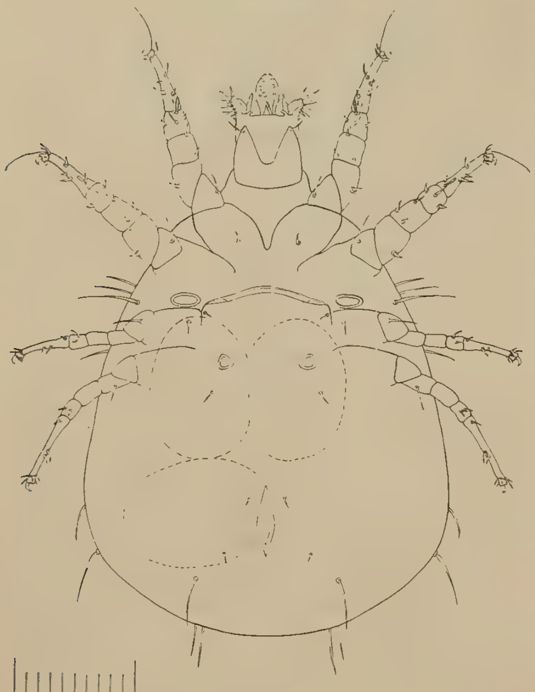

FIG. 1.—*Histiostoma laboratorium*, n.sp.: Adult female, ventral view.

Because of its size, compactness, and complexity the gnathosoma is difficult to interpret. The details appear to be as follows: Dorsally the propodosoma overhangs the gnathosoma obscuring about one-third of it. The chelicerae are delicate structures, wide at the base, and tapering anteriorly. Each structure bears numerous teeth on its mesial side and terminates in a fine bristle with a minute knob, which is probably sensory in function. A few hairlike setae are found in a medial position possibly attached to the basal portion of chelicerae. The

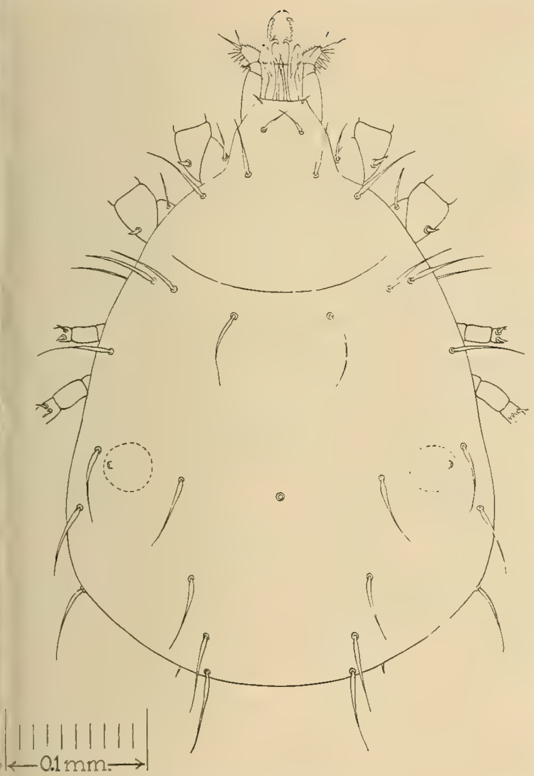

Fig. 2.—*Histiostoma laboratorium*, n.sp.: Adult female, dorsal view.

chelicerae are rapidly extended and retracted, apparently with a "raking" action, while the animal is feeding. The pedipalps appear to have three segments with indistinct lines of separation. Segment 1 bears one prominent spinelike seta. Another distinct but smaller seta can be seen slightly posteriad of this seta, arising either from the same pedipalpal segment or from a closely associated structure. Segment 2 bears one small seta. The basal segment is without setae, unless what appears to be a labial seta (Fig. 1) is actually a seta taking its origin from the base of the pedipalp. Mesially a pair of rather prominent pointed processes are found partially surrounding the chelicerae. Presumably these structures arise from the bases of the pedipalps. Extending from the pedipalps laterally are many extremely fine hairs, which apparently do not arise directly from the pedipalpal segments but from a thin membrane associated with it. Dorsally and mesially of pair of lacinialike structures are seen to be associated with the pedipalps.

Legs I and II are typically directed anteriorly and legs III and IV posteriorly. Locomotion is accomplished by a pulling action by I and II and a pushing action by III and IV. Legs I and II are approximately of equal length and are broader and much more robust than legs III and IV. The arrangement and type of setae and other structures of all the legs of the female are shown in Fig. 1. All setae are shown in this figure as taking their origin from the mesial sides of the legs. Fig. 5 is an enlarged view of leg I showing the setae in their true relationships. The setae, or portions of setae, lying on the lateral side are shown in broken lines.

It will be noted that only legs I and II have the very long hairlike setae at the tip of the tarsus. Otherwise the general arrangement and size of the claws, rudimentary caruncles, and setae at the distal end of the tarsus are the same for all legs. However, tarsus I has one large extra spine distally not found on other tarsi. In addition to these spines and spinules tarsus I has five other spines, tarsus II four other spines, and tarsi III and IV three other spines. Tarsus II also has a conspicuous striated macrosense organ at its proximal end. Tibiae I and II have three spines, and tibiae III and IV only two spines. In addition, tibia I has a macrosense organ of the same size and structure as found on the proximal end of tarsus II. Arising from the same base as this macrosense organ is found a rather

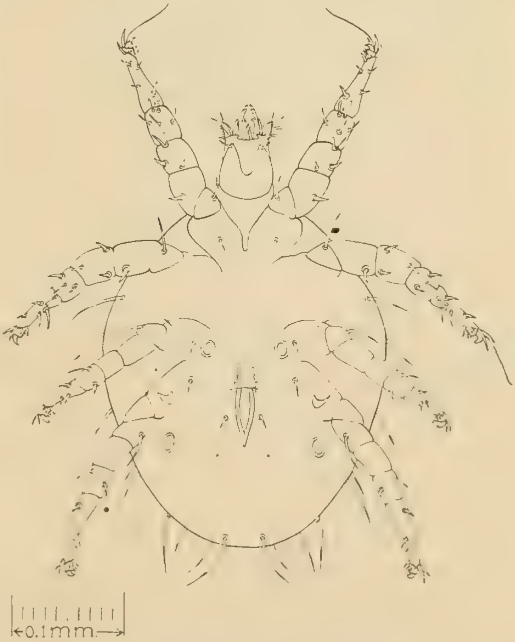

Fig. 3.—*Histiostoma laboratorium*, n.sp.: Adult male, ventral view.

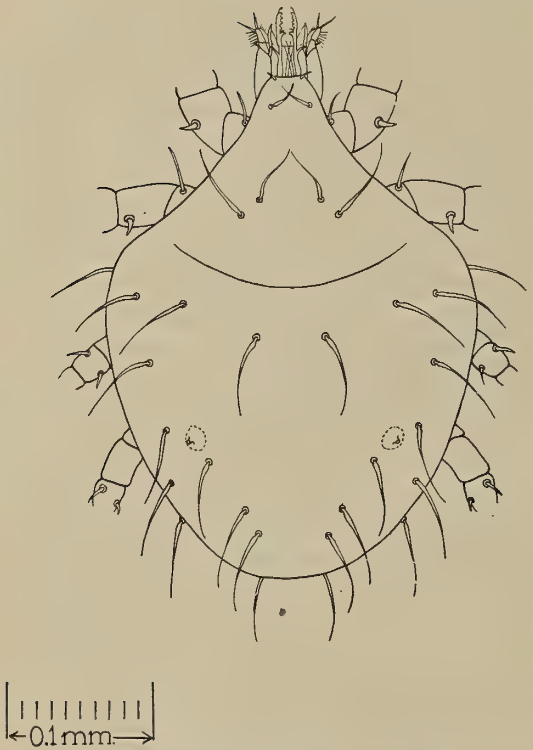

FIG. 4.—*Histiostoma laboratorium*, n.sp.: Adult male, dorsal view.

peculiar long bristle with a rounded tip. There are two spines of typical shape on genua I and II, and no spines on genua III and IV. On the distal end of genu I there is, in addition, a pair of setae arising from the same base; one of which is long and thin, and the other bristlelike and similar to the seta that arises from the base common to the macrosense organ of tibia I. Femora I and II have a single spine, femur III no setae, and femur IV one long almost hairlike seta. Trochanters I, II, and III have one seta, each very similar to that described for the femur IV. Trochanter IV has no seta.

Male (Figs. 3, 4, 5).—Average length of male exclusive of legs and setae extending beyond the body 0.38 mm; average width 0.23 mm. The variation in length of specimens over six days old is from 0.33 mm to 0.40 mm; variation in width 0.17 mm to 0.25 mm. There is a marked sexual dimorphism in this species, this being apparent even under low magnification. The male is shield-shaped, with a small tapering opisthosoma. This latter character emphasizes the conspicuousness of the legs, which are in fact more robust than those of the female, especially legs III and IV, even though the body of the male is much smaller. Also the male can be easily distinguished from a female under low magnification by the extension of his fourth pair of legs posteriorly in a virtually immobile position during locomotion. They are, however, efficient grasping appendages during copulation. Aside from the obviously more robust legs of the male, as pointed out above, the sexual dimorphism is evident in the details of the setae of the legs as well. This is true even though the general arrangement and number of the setae is the same in both sexes and there is no difficulty in establishing homologies. An example of these differences is seen when leg I of male and female are compared (Fig. 5). Dorsally the male differs from the female in a most unexpected manner, namely, the male has one less pair of long opisthosomatic setae. It is not certain which pair is missing in the male, but it may be assumed that it is the pair in the female lying on a level with the excretory organs and mesiad of them. The excretory organs of the male are more anteriorly placed than in the female. On the ventral surface of the male the same four ring-shaped structures of unknown function are found. The position of these structures differs considerably from those in the female. The anterior pair is ring-shaped in contrast to the sole-shape condition in the female and slightly posterior to trochanter III. This pair is also more mesiad. The posterior pair is much more laterad than in the female and posteriad of trochanter IV. The anal slit of the male also contrasts with position of the anal slit in the female. In the male it lies on the same level as trochanter IV, whereas in the female it is more posteriad. The number of small spinelike setae on the ventral surface of the male is the same as in the female. The arrangement of these setae appears to be quite different in the male and female at first glance. The pattern for the male is as follows: one pair slightly above a line between trochanters II, one pair on a level with trochanters III, one pair just laterad to the anterior ring-shaped structures, one pair more or less on a level with trochanters IV, and two pairs near the posterior part of the anus. The most posterior pair of anal setae are extremely small and difficult to see. Aside from the genital apparatus, the ventral surface of the male differs from the female in another feature. Near and slightly mesiad of trochanters IV an obscure boss, or elevation is found. It does not appear to be a part of the apodemata in this region. The male genital opening is at the anterior end of the anal slit. It has two pairs of spinules at its posterior margin. On several occasions a very minute erectile structure in this region has been seen. This structure is presumed to be a penis. Normally it appears to be retracted into a groove in the anterior end of the anal slit, although the above structures are not entirely clear. During copulation the male mounts the female dorsally in such an attitude that the genital apparatus is in juxtaposition with the bursa copulatrix of the female. All other features of the male not described above, such as the gnathosoma, are essentially the same as in the female.

Hypopus (Figs. 5, 6, 7).—Average length exclusive of legs 0.18 mm; width 0.14 mm. Variation in length from 0.16 mm to 0.20 mm; width 0.12 mm to 0.16 mm. Color light to dark amber. The hypopus is apparently mouthless, the gnathosoma being represented chiefly by a pair of antennalike setae, which arise from a common base. The legs are extremely long for the size of the body, enabling the hypopus to crawl rapidly over the culture medium or other surfaces. The hypopus is very resistant to desiccation and is not harmed after long periods in a completely liquid medium.

The most prominent structure ventrally is the suctorial plate. Eight conspicuous discs are seen in this plate; an anterior pair of medium

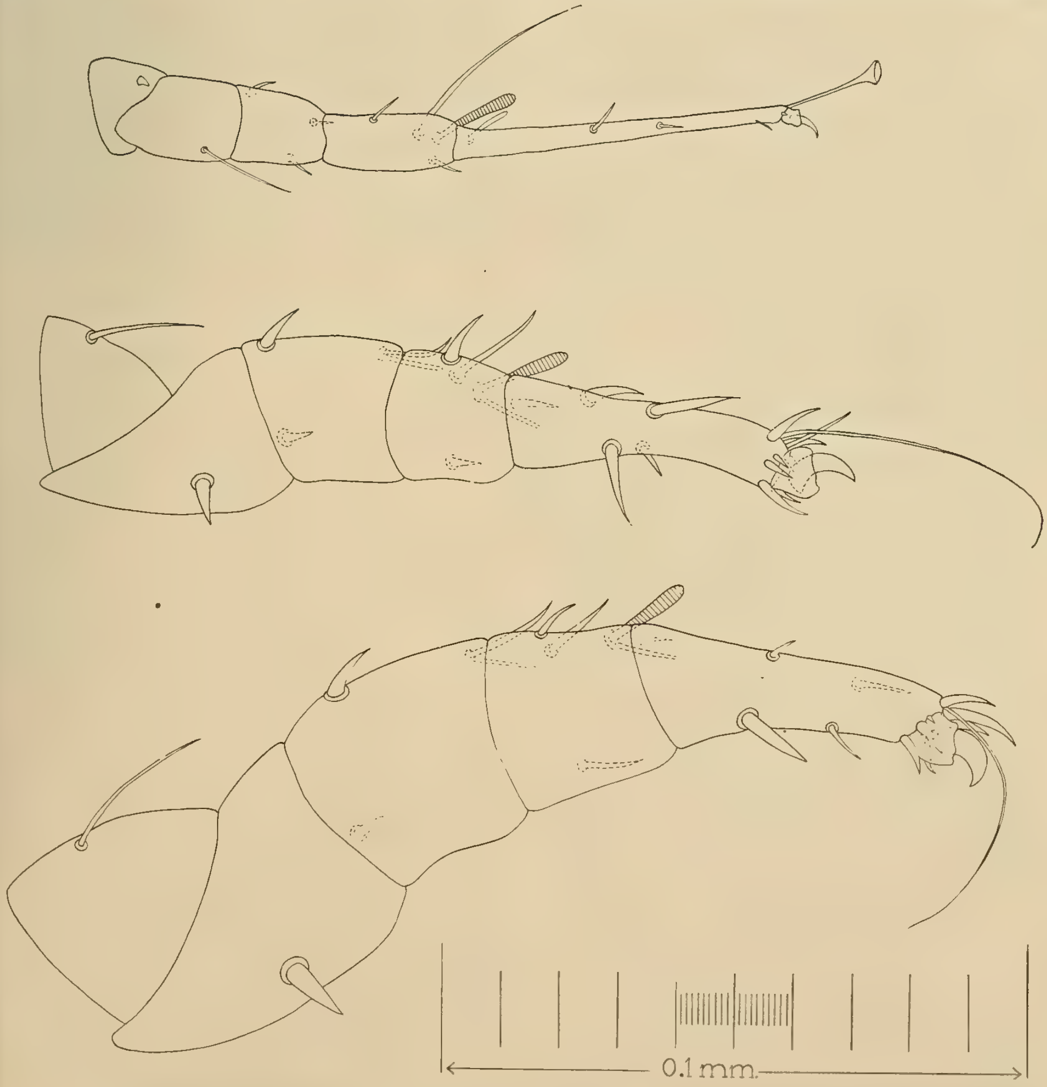

Fig. 5.—*Histiostoma laboratorium*, n. sp.: Legs I, hypopus (upper figure), adult female (middle), adult male (lower).

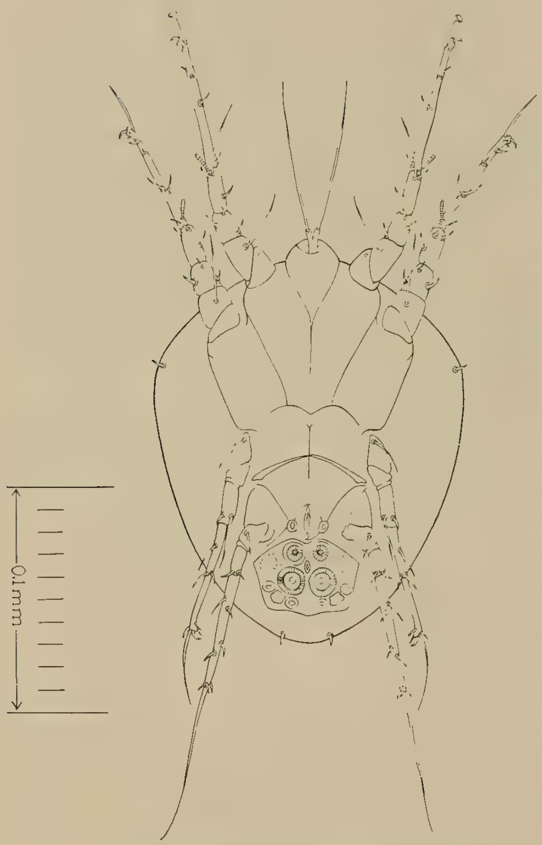

FIG. 6.—*Histiostoma laboratorium*, n.sp.: Hypopus, ventral view.

size, a middle pair of large size, and a posterior row of four small ones. The anterior pair of discs may be extended three or four times their diameters and are obviously suckers. The middle pair appear to be suckers also but have not been seen in an extended position. The structure of the four small posterior discs is different from the above discs, and it appears very doubtful if they can function as suckers. In addition to the above eight discs there is a pair of very faint ringlike structures, one on each side of the anterior suckers. They appear to be incipient suckers, but there is no real evidence for this. In each posterolateral corner of the plate there is a faintly visible structure of unknown function. Directly anterior to the suctorial plate there is a slit having the appearance of the anus in the adult. On each side of this slit is a disc somewhat similar in size and shape to the four discs on the posterior margin of the suctorial plate. Also there are two pairs of very faint rings between the slit and the discs mentioned above. Ventrally two pairs of minute submarginal setae are observed. One pair is anterolaterad, and one pair at the posterior end. The coxae and apodemata are outlined in the ventral view of the hypopus (Fig. 6). Dorsally a distinct sulcus is present. The propodosoma has one row of four small setae. The hysterosoma has a faintly striated, shagreened appearance. There are four rows of small setae on the hysterosoma; six setae in the first or anterior row, six in the second, four in the third, and only two in the last row. The hypopus is finely granular both dorsally and ventrally. The number and arrangement of the leg setae, and other leg structures of the hypopus, are not, as expected, identical with the adult. However, there is no difficulty in homologizing many of these structures with those of the adult. These setae and structures are shown for all the legs in Fig. 6. and an enlarged view of leg I is shown in Fig. 5. Mention many now be made of some of the more conspicuous differences between the hypopus and adult legs. A single claw is found on the tarsus of each of the first three legs, but not on tarsus IV. In the latter there is an extremely long, thin seta instead of

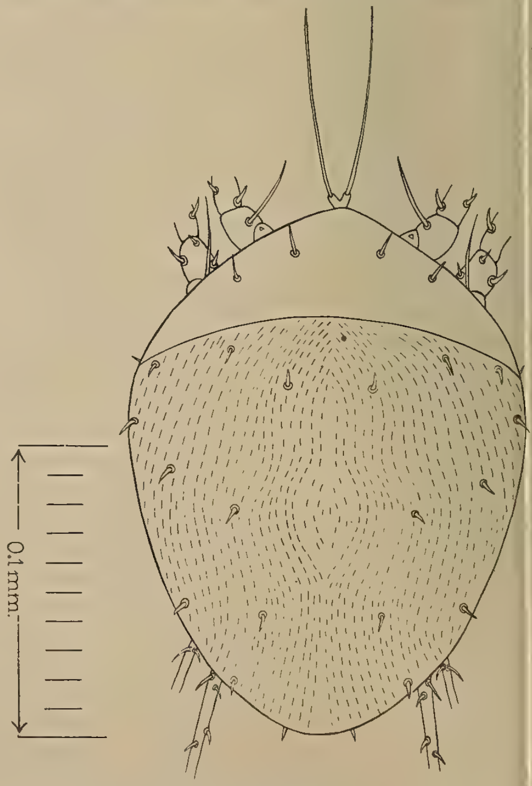

FIG. 7.—*Histiostoma laboratorium*, n.sp.: Hypopus, dorsal view.

a claw. Tarsi II and III have rather long hairlike setae similar in appearance to those on tarsi I and II of the adult. Tarsus I has a structure with a shape similar to the end of a golf club substituted for similarly placed setae on tarsi II and III. This structure could possibly function as either a suction cup or a sensory organ. The tarsal spinules of adult legs appear to be missing in the hypopus. These could be present but of such a minute size as to be overlooked. The macrosense organs are seen in a similar position to those of the adult, although no bristlelike setae have a common origin with them as seen in the tibial macrosense organ of leg I of the adult. Only trochanter III of the hypopus has a seta. However, femora I, II, and IV have long setae somewhat similar in shape and size to the setae on trochanters I, II, and III of the adult. Trochanter I has an extremely minute spicule reminding one of an incipient seta. The interpretation of the segments of leg III and IV is shown in Fig. 6. If this interpretation is correct genua III and IV are represented in the hypopus by small, almost vestigial segments.

Type.—Holotype male, allotype female and hypopus, and several paratypes of both sexes and hypopus are being deposited in the U. S. National Museum.

Remarks.—These studies were based on many specimens, conforming to type forms. The most satisfactory observations were made on living specimens mounted in Methocel, which slows but does not kill for as long a period as several hours. Colonies of this species were started from specimens originally found in a *Drosophila* culture from a biological supply house.

This species is easily cultured on any of the common *Drosophila* culture media, such as cornmeal-molasses-agar. At room temperature the life cycle is completed in 5 to 6 days. Unfertilized eggs obtained from isolated virgin females give rise to males only, furnishing another instance of haploid parthenogenesis in the Acarina. It is suspected that the natural distribution of his species is widespread. This statement is based on preliminary collections in the vicinity of Richmond, Va., as well as the general observation of its frequent occurrence in genetic laboratories in many parts of the United States. The normal variation in size of mites of the same species of a family when cultured under optimum condition is not known. However, the size range as noted above appears to be unusually great, leading one to suspect genetic differences are involved. This and other aspects of the biology of this species are now under investigation.

ENTOMOLOGY.—*A synopsis of the chloropid genera* Chaetochlorops *and* Eugaurax *(Diptera)*.[1] Curtis W. Sabrosky, Bureau of Entomology and Plant Quarantine.

In the family Chloropidae, a formula of 1+2 notopleural bristles (one anterior and two posterior) occurs so generally that it might almost be cited as a family character. Some genera and species have 1+1, or occasionally 0 + 1, but even in these cases close inspection sometimes shows that the difference is only one of degree and that there is present in the expected position a single hair or hairlike bristle corresponding to the apparently missing notopleural.

In the New World two genera, *Chaetochlorops* and *Eugaurax*, show unexpected numbers of notopleurals, the formula ranging from 2 + 3 to 3 + 17, with correspondingly greater numbers than usual along the posterior margin of the mesonotum and on the sides of the scutellum. In view of their distinctive habitus, the two genera may conveniently be considered together in this paper. Actually they are derived from quite different lines, however, as *Chaetochlorops* belongs with the *Epimadiza-Goniopsita-Polyodaspis* complex of genera, whereas *Eugaurax* is near *Conioscinella*.

The two genera may be separated by a number of significant characters, besides the useful though perhaps superficial difference in color.

KEY TO CHAETOCHLOROPS AND EUGAURAX

1. Postvertical bristles stout, straight, parallel or slightly diverging, directed slightly caudad; eye bare, at most a few exceedingly minute hairs visible under high magnification; front rather shining (the German "fettglänzend"),

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[1] Received March 30, 1950.

without pollen; proboscis elongate and geniculate, with both sections slender, corneous, and nearly as long as greatest length of head; thorax polished black, rest of body and legs predominantly so. (*Chaetochlorops* Malloch) 2

Postvertical bristles straight and strong, but cruciate at tips; eye distinctly pubescent; front dull; proboscis short, the labella broad and fleshy, not 0.40 as long as greatest length of the head; yellow species with reddish to black stripes on mesonotum. (*Eugaurax* Malloch) 3

CHAETOCHLOROPS

2. Fore coxa black (definitely infuscated even in teneral specimens); cheek relatively broad, 0.31–0.40 times height of an eye and 0.83–1.0 times breadth of third antennal segment; Nearctic............*C. inquilina* (Coquillett)

Fore coxa testaceous, sharply contrasted with black femora; cheek appearing narrower, 0.25–0.30 times height of an eye and 0.74–0.90 times breadth of third antennal segment; Neotropical...........*C. scutellaris* (Becker)

EUGAURAX

3. Presutural bristle absent; thoracic chaetotaxy not extreme, with only one row each of prescutellar and marginal scutellar bristles, no intrahumerals, and usually only one strong humeral, if any......................... 4

Presutural bristle present, sometimes 2 or 3 bristles in the presutural position; thorax strongly bristled as in *Chaetochlorops* (except in *E. intermedia*), with numerous humeral and intrahumeral bristles, 2 or 3 somewhat irregular rows of prescutellars, and 2 or 3 rows of marginal scutellars.................... 8

4. Mesonotal stripes polished black, not at all pollinose; 4 black pleural spots, on meso-, sterno-, ptero-, and hypopleuron; cheek broad, subequal to breadth of third antennal segment and 0.40 times height of an eye (Chile)................*E. pleuralis* Malloch

Not as above, the entire mesonotum somewhat duller, sparsely or distinctly covered with pale pollen (unknown for *bipunctata*, but that species has entirely yellow pleuron); cheek obviously narrower than the proportion stated above......................... 5

5. South Temperate Zone species (Argentine, Uruguay)[2]................................. 6

North Temperate Zone species (Florida to Canada).............................. 7

6. Back of head with black spot above the neck; mesonotum with black markings confined to a streak on each side between mesonotal suture and hind margin[3].....*E. bipunctata* Malloch

Back of head entirely pale yellow; mesonotum with four brown to black stripes, the central pair nearly fused[3]........*E. bicolor* Malloch

7. Mesonotum light yellow with three (or four)[4] stripes, typically the broad median stripe entirely reddish except on anterior declivity opposite the occipital spot, and the lateral stripes reddish with posterior two-fifths black, the over-all effect being a predominantly reddish notum with two elongate-oval lateral black spots on posterior third; black occipital spot small, opposite middle of eye and separated from the eye by a yellow band at least twice as wide as the ocellar triangle; hypopleuron yellow; southeastern U. S. *E. floridensis* Malloch

Mesonotum with three (or four) broad black stripes; occipital spot much more extensive, the post-ocular yellow band separating it from the eye equal to or little more than the distance between posterior ocelli; hypopleuron with elongate-oval black spot; northeastern U. S., southeastern Canada. *E. floridensis vittata*, n. subsp.

8. Thorax with only one row each of prescutellar and marginal scutellar bristles; no intrahumeral bristles (Costa Rica). *E. intermedia*, n. sp.

Thorax more strongly bristled, with two or three somewhat irregular rows of prescutellar bristles and two or three rows of marginal scutellars; cluster of intrahumeral bristles mesad of each humerus.................. 9

9. Two rows of moderately strong, black bristles along lower margin of cheek (Colombia, Panama).....................*Eugaurax* sp.

Cheek with short, fine, pale yellow hairs along lower margin. *Eugaurax* spp. (*quadrilineata*, etc.)

Genus **Chaetochlorops** Malloch

Chaetochlorops Malloch, Can. Ent. **46:** 120. 1914. One species. Type, *Siphonella inquilina* Coquillett, by original designation and monobasic.

As I have pointed out elsewhere in a review of the Chloropidae of the Ruwenzori Expedition (Brit. Mus. Nat. Hist., in press), the Old World genera *Anacamptoneurum*, *Polyodaspis*, *Epimadiza*, and *Goniopsita* and the New World genus *Chaetochlorops* are all closely related and form a distinct group. It is even probable that fewer genera should be recognized, but conclusions must be based on a broader study than in possible at this time. The species of *Polyodaspis* are intermediate between normally bristled *Goniopsita* and strongly bristled *Chaetochlorops*. Even the development in *Chaetochlorops* of a strong presutural bristle cannot be considered a generic character, for it is also developed in some African *Polyodaspis*, though not in the Palearctic genotype, *P. ruficornis* (Macquart). Likewise, some species of *Eugaurax* have presuturals, though others do not.

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[2] Having no material of *bipunctata* and *bicolor* for study, I can only include them here, for completeness, by geographical division.

[3] After Malloch, *Diptera of Patagonia and S. Chile*, pt. 6, fasc. 5: 422–425. 1934.

[4] The median pair of stripes, in all *Eugaurax*, may be narrowly separated, either full length or partly, or may be fused to form one broad median stripe which is about twice the width of a lateral stripe.

In Chile there is a parallel case in another genus. *Hippelates stigmaticus* (Duda) (syn., *Chaethippus subannulatus* Malloch) has usually about 3 + 5 notopleural bristles, a strong presutural bristle, a transverse row of prescutellars, and more lateral scutellars than usual. However, because *stigmaticus* is a reasonably characteristic *Hippelates* s. str., i. e., a dull, heavily gray pollinose species with a strong, curved hind tibial spur, the development of bristles appears in this case also to be of only specific significance.

In both *Eugaurax* and the Old World *Polyodaspis* the development of the presutural bristle seems to be characteristic of tropical forms.

Chaetochlorops inquilina (Coquillett)

Siphonella inquilina Coquillett, Journ. New York Ent. Soc. **6**: 48. 1898a (Va., Mo.); U. S. Dept. Agr. Div. Ent. Bull. 10 (n. s.): 75. 1898b (habits).

Chaetochlorops inquilina (Coquillett) Malloch, Can. Ent. **46**: 120. 1914.

As with many of Coquillett's species, no holotype was clearly designated in publication, though in the collection a red "type" label was placed on the specimen bearing his name label, and red "paratype" labels on the remaining specimens. To be definite, and to avoid confusion with those who believe that the phrase "Type No. 3807, U. S. Nat. Museum" did designate the type (as Coquillett perhaps intended), I hereby select as lectotype the specimen which carries the red "type" label, Coquillett's name label, and the further labels "No. 931" and "Puparium found in apple. Iss. May 28–81." No locality is given. The data are elaborated slightly in Bulletin 10, p. 75 (l. c.), based on original notes by Theodore Pergande, to which the no. 931 refers.

Distribution of *inquilina:* Widely distributed in the eastern and middle States, from Massachusetts to Florida and west to South Dakota and Texas, to judge by over 150 specimens personally identified from 51 localities in 23 States and the District of Columbia, as follows: Alabama, Arkansas, Connecticut, District of Columbia, Florida, Illinois, Indiana, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Mississippi, Missouri, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Texas, Virginia, West Virginia. Westernmost records: Elk Point and Canton, S. Dak.; Onaga, Kans.; Ada and Hugo, Okla.; Ebony and Brownsville, Tex. Collecting records range from April 25 (District of Columbia) to October 3 (New Jersey) in the north, and February 17 (Brownsville, Tex.) to September 30 (Mississippi) in the south.

Notes on some interesting behavior, possibly courtship, of the adults of this species were published by Steyskal (Brooklyn Ent. Soc. Bull. **37**: 102. 1942).

Food habits of larvae: Knowledge of the food of most Chloropidae is slight or nonexistent, and it is always of significance to record what is known. In this instance the species appears to be reared more often than it is collected, and there is accordingly a surprisingly large accumulation of rearing records. Few of these critically determined the exact food and whether the larvae were parasitic, predaceous, or saprophagous. Though it is not impossible that the larvae may be parasitic or predaceous, at least at times, the fact that they are associated with damage by such a wide variety of insect pests to many different kinds of plants suggests that they feed in frass and decaying plant tissues together with or following the primary cause of the damage.

The rearing records known to me have been arranged in the following list according to the insect with which *inquilina* larvae were associated. In a second list they are arranged by the host plant, for those cases where no other is specifically mentioned on the labels.

Acrobasis caryae Grote (pecan nut casebearer): "Two flies . . . emerged from puparia inside of the [fifth stage] host larva" (Ebony, Tex.).

Anthonomus grandis Boheman (boll weevil): "In rotten cotton bolls" (Tuscaloosa, Ala.); "Par[asite] *Anthonomus grandis*" (Alexandria and Tallulah, La.; Hugo, Okla.); "bred from cotton squares" (Laurinburg, N. C., *fide* Brimley, 1938, *Insects of North Carolina*, p. 387); "reared from boll weevil infested cotton sq[uare]" (Florence, S. C.).

Carpocapsa pomonella (Linnaeus) (codling moth): Puparium found in large cavity in apple, presumably made by codling moth (lectotype); about 150 specimens "reared from wormy apples," June–July 1940 (Glassboro, N. J., *teste* E. J. Hansens, in litt.); further specimens, August 1943, believed to be "breeding in the frass [from codling moth larvae] or in the rotting apples themselves" (Glassboro, N. J., *teste* W. F. Rapp, Jr., in litt.).

Conotrachelus spp. (nut curculios): From puparia found with *Conotrachelus* larvae [probably *aratus* Germar] attacking base of compound leaves of *Hicoria* sp. (Lyme, Conn.); "reared from pecan twig injured by *Conotrachelus aratus*" (Miss.); listed as a rather abundant and important "parasite" of the butternut, black-walnut, and hickory-shoot curculios, *Conotrachelus juglandis*, *C. retentus*, and *C. aratus* (Brooks, U. S. Dept. Agr. Dept. Bull. 1066: 7, 11, 16. 1922).

Ecdytolopha insiticiana Zeller: Par[asite] of *E. insiticiana* in *Robinia*" (Falls Church, Va.).

Epiblema scudderiana (Clemens): Bred from *Euryptychia saligneana* [= *E. scudderiana*] in galls from *Solidago* (presumably Vineland, N. J.). Associated notes state that the specimen was sent to C. V. Riley, September 23, 1870, by "Mrs. Treat," probably Mrs. Mary Treat, of Vineland, N. J., mentioned in Riley's Missouri reports. The specimen has not been located, but Coquillett's record can be accepted without question.

Grapholitha molesta (Busck) (Oriental fruit moth): "Emerged in cage with *L[aspeyresia] molesta* larvae" (Chambersburg, Pa.).

Itonidid galls on *Rudbeckia*: "The gall when first found did not contain any cecidomyiid, and the *Siphonella* had evidently lived as an inquiline after the original occupants had abandoned the gall" (St. Louis, Mo.; lectoparatypes; reported by Coquillett, 1898b, *op. cit.*, p. 75 as reared from gall on *Aster*, but the plant was later determined as *Rudbeckia laciniata*); "*Cecidomyia* galls on *Rudbeckia laciniata*" (Penryn, Pa.)

Laspeyresia caryana (Fitch): "In pecan hulls with *Laspeyresia caryana*" (Mound, La.).

Proteoteras aesculana Riley: "Pupae found inside burrow" in young shoots of young maple trees, made by *Proteoteras*, May 30, 1873, noted by O. Lugger (probably Missouri).

Psacaphora cephalanthiella (Chamb.): "Adults . . . issued from twigs of *Cephalanthus occidentalis* . . . ; the twigs were also infested by caterpillars of *Laverna cephalanthiella* Chamb." (Va., recorded by Coquillett, 1898b: 75; 24 lectoparatypes).

Pyrausta penitalis Grote: "Bred from the boring in stem of *Polygonum*, probably done by the above moth [*P. penitalis*]" (Lafayette, Ind.).

Rhyssomatus lineaticollis Say: "Bred from decayed seed pods of *A[sclepias] syriaca* . . . first injured by the larvae of *Rhyssematus*" (New Brunswick, N. J., *fide* Weiss and Dickerson, Journ. New York Ent. Soc. 29: 144. 1921).

Tortrix on rose: "Par[asite] on Tachinid on *Tortrix* on Rose" (Kirkwood, Mo.).

Records associated only with a plant, as far as data on labels are concerned, are the following:

Ambrosia: "Bred from *Ambrosia trifida*" (Kinderhook, Ill.).

Bidens: "Bred from stem of *Bidens*" (Greenport, L. I., N. Y.).

Carya: "Bred from hickory nuts" (A & M College, Miss.).

Carya illinoensis: "*Hicoria pecan*" (Logansport, La.).

Cucurbita pepo: "Bred from old pumpkin vines" (Washington, D. C.).

Datura: "Bred from *Datura stramon[ium]* pod" (Ada, Okla.).

Helianthus: "Reared from sunflower decay," "reared from sunflower floret," and "*Helianthus annuus*" (Webster Groves, Mo.).

Hibiscus: "Bred from *Hibiscus*" (Chesapeake Beach, Md.).

Juglans cinerea: "Bred from shuck of butternut" (Plummers Island, Md.).

Solanum: "Emerged from a berry of *Solanum carolinense*" (Kirkwood, Mo.; lectoparatype, record published by Coquillett, 1898b, *op. cit.*, p. 75).

Zea: "Bred from stored corn" (Bladensburg, Md.).

Chaetochlorops scutellaris (Becker)

Siphonella scutellaris Becker, Ann. Mus. Nat. Hung. **14**: 449. 1916. (Higuito, Costa Rica).

Goniopsita inquilina (Coquillett) (syn. *scutellaris*) Duda, Folia Zool. Hydrobiol. **2**: 73. 1930.

Chaetochlorops inquilina (Coquillett) (syn. *scutellaris*) Duda, Konowia **12**: 200. 1933.

I do not agree with Duda in placing *scutellaris* in synonymy. The two species are unquestionably very similar, but the consistent difference in the color of the fore coxa and in the proportionate width of the cheek convinces me that two species are involved.

Specimens examined: In addition to the holotype [Hungarian National Museum, Budapest], I have seen 18 specimens, all from the type locality. Aldrich (Card Catalogue, U. S. National Museum) has also recorded it from Barro Colorado Island, Panama Canal Zone (J. Zetek), "from *Bombacopsis fendleri*."

Genus **Eugaurax** Malloch

Eugaurax Malloch, Ins. Insc. Menstr. **1**: 46. 1913. One species. Type *E. floridensis* Malloch (original designation and monobasic).

Eight described species are referable to *Eugaurax*, to which number are added in this paper one new species, one new subspecies, and one unnamed species. On the presence or absence of presutural bristles, the species fall into two groups, which correspond also with a geographical division. Four described species and the new subspecies, lacking presuturals, are Temperate Zone forms, either north or south. The others, possessing one or more presuturals, are tropical to subtropical. In all but one of this second group, the posterior part of the thorax is also densely bristled, with two or three irregular rows of prescutellars and a like number of rows of marginal scutellars. The exception, *E. intermedia*, n. sp. (Costa Rica), has a presutural bristle, but only one row each of prescutellars and marginal scutellars, and is thus intermediate between the tropical and temperate zone species.

Nothing is known of the food habits of the larvae. The only clue known to me is that a series of specimens in the collection of the U. S. National Museum, from Spring Lake, Fla., February 28 and March 3, 1930 (N. C. Nicoll), is labeled "Egg plant." The specimens are teneral and may have been reared.

SPECIES OF SOUTH TEMPERATE ZONE

Eugaurax bicolor Malloch, Diptera Patagonia and S. Chile, pt. 6, fasc. 5: pp. 422, 424. 1934. (Buenos Aires, Argentina).

Eugaurax bipunctata Malloch, ibid.: 422, 423 (Montevideo, Uruguay).

Eugaurax pleuralis Malloch, ibid.: 422 (Chile).

E. pleuralis is the only species of *Eugaurax* known to me which has the mesonotum polished, lacking the pollinose appearance of the others. It is also unique in its broad cheek and black-spotted pleuron.

Eugaurax floridensis Malloch

Eugaurax floridensis Malloch, Ins. Insc. Menstr. 1: 46. 1913. (Fla., N. J.).

Little can be added to Malloch's description, except to note the error, undoubtedly a *lapsus calami*, in crediting the species with "two notopleural and four supraalar bristles." All are notopleurals, two anterior and four posterior, a formula that occurs in all five specimens known to me. The mesonotal pattern is characteristic. The narrow occipital spot is conspicuously bidentate dorsally by reason of a large V-shaped yellow area behind the frontal triangle.

Specimens examined: Holotype female, Biscayne Bay, Fla., and two paratypes (♂, ♀), Atlantic Beach, Fla.; ♀, Sebastian, Fla., February 10, 1919 (A. Wetmore) [U. S. National Museum]; ♀, Jackson County, Iowa, June 15, 1934 (H. C. Knutson) [Iowa Wesleyan College].

The only published record known to me is "NY" in the "List of the Insects of New York" (1928, p. 861), but it is probable that this really refers to *E. floridensis vittata*. The paratype from Riverton, N. J., "7-3-98," which is not typical *floridensis*, is somewhat intermediate with *vittata*.

Eugaurax floridensis vittata, n. subsp.

As described for *floridensis* but with much darker habitus, differing in having three (or four) broad black mesonotal stripes, a broader occipital spot, and a hypopleural spot. There is some variation in the number of posterior notopleurals, with two specimens having five and six, but with so few specimens this does not necessarily indicate a characteristic trend for the northern race. No difference was observed in the male genitalia.

Holotype female and allotype, Lafayette, Ind., August 4 (J. M. Aldrich). U.S.N.M. type no. 59626. Paratypes: 2 (♂, ♀), topotypical, June 16, 1915 and August 5 (Aldrich) [USNM]; ♂, Algonquin, Ill., May 29, 1896 [Illinois Nat. Hist. Survey]; 2 (♂, ♀), Norway Bay, Quebec, August 24, 1938 [Canadian National Collection].

The paratype of *E. floridensis* Malloch from Riverton, N. J., is intermediate but closer to *vittata*, as noted above.

Eugaurax intermedia, n. sp.

Female: Predominantly light yellow, marked with black as follows: Arista except for thickened basal segment, ocellar spot, moderately broad occipital spot, three mesonotal stripes posterior to mesonotal suture, metanotum, and dorsum of abdomen except for large basal spot and narrow yellow margins and apex; mesonotal stripes dark reddish anterior to suture, but this color is probably variable; median stripe twice the width of a lateral and extending beyond the latter to the base of the scutellum; supraalar area and pleuron entirely yellow; bristles brown to blackish.

Front somewhat collapsed, in life probably narrower than an eye; cheek narrow, one-seventh the height of an eye and less than half the breadth of the third antennal segment, the lower margin with short, fine, pale yellow hairs; third antennal segment subreniform, 1.5 times as broad as long; arista long pubescent; thoracic chaetotaxy: 1 weak, hairlike humeral, 2 + 5 notopleural, 1 presutural, 2 postalar, 10 bristles in single prescutellar row, and 1 apical and 4-5 marginal scutellars in a single row. Venation normal for the genus.

Length, 2 mm.

Holotype female, Higuito, San Mateo, Costa Rica (Pablo Schild). U.S.N.M. type no. 59627.

Although this species is represented by a unique specimen, I have no hesitation in describing it at this time because of the distinct chaetotaxy. It possesses a presutural bristle as do the other tropical species, but unlike the others it has only single rows of prescutellar and marginal scutellar bristles.

Eugaurax sp.

Three specimens, one collected at Las Palmas near Pacora, Panama, one at Miami, Fla., on plane from Barranquilla, Colombia, and one at Brownsville, Tex., on plane from the Canal Zone, indicate the presence of a distinct species in Central America. None of the specimens is in good condition, however, and the species will not be described until more material is available. The strong cheek bristles are a distinctive feature, compared with other known species of the genus.

Eugaurax spp. (**quadrilineata**, etc.)

Four described species pass to the end of the key, as follows:

Eugaurax quadrilineata (Williston), Diptera of St. Vincent: p. 422. 1896 (*Oscinis;* St. Vincent); Coquillett, Proc. U. S. Nat. Mus. **22:** 266. 1900 (*Oscinis;* oc. Puerto Rico); Duda, Folia Zool. Hydrobiol. **2:** 99. 1930 (*Conioscinella;* oc. Costa Rica). NEW COMBINATION, from type in British Museum (Nat. Hist.).

E. insularis Malloch, Ins. Insc. Menstr. **1:** 64. 1913 (Puerto Rico). Although not so stated in the original description, the type and paratype of *insularis* appear to have been the specimens recorded by Coquillett (1900) as *quadrilineata.*

E. hystrix (Duda), *op. cit.* : 99. 1930 (*Conioscinella;* Brazil). NEW COMBINATION, from holotype male, Petropolis, Brazil (Borgmeier) [type in Instituto Biológico, São Paulo, Brazil, lent for study through the courtesy of the late Oscar Monte.].

E. fasciventris (Duda), *op. cit.:* 102. 1930 (*Conioscinella formosa* var.; Peru). NEW COMBINATION, from female, presumably holotype, Callao, Peru, June 3, 1913 (R. Paessler), examined 1937 in Zoologisches Museum at Hamburg, Germany (type now destroyed).

In addition to the type and paratype of *insularis*, I have before me 23 specimens, chiefly teneral or in mediocre condition, from Florida (Biscayne Bay, Cape Sable, Spring Lake), Cuba, Jamaica, and the Panama Canal Zone. Possible differences may exist in the width of the front and in the presence or absence of black supraalar vittulae, but the present material is not suitable for further study. I am inclined to believe that at least *insularis* and possibly *hystrix* are synonyms of *quadrilineata*, but these and other questions must await adequate series in good condition.

ZOOLOGY.—*Some new and rare Pacific pagurids.*[1] BRYCE C. WALTON, Allan Hancock Foundation, University of Southern California. (Communicated by F. A. CHACE, Jr.)

The comparatively recent existence of a juncture between the Atlantic and Pacific Oceans in what is now the Panama area would presuppose the existence of rather closely related decapod forms on the two sides of the isthmus. A preliminary examination of the Paguridea collected by the Allan Hancock Pacific Expeditions disclosed the presence of the following two undescribed species, which are closely related to rather unique Caribbean forms not previously reported from the Pacific side, and also a series of both sexes of a rare scutellated hermit previously known only from the Bay of Panama.

Family PYLOCHELIDAE Spence-Bate, 1888

Genus **Parapylocheles** Alcock, 1905

Parapylocheles glasselli, n. sp.

Fig. 1

Type.—Male holotype, A.H.F. no. 401, from Ensenada de San Francisco, Sonora, Mexico, 16 fathoms; collected February 7, 1940, by the *Velero III* at station 1087-40.

Diagnosis.—Chelipeds equal, similar, devoid of spines or granules. Carapace smooth, polished, precervical portion a little longer than wide. Rostral point broad, triangular, with truncate apex, extending between the base of eye stalks, lateral points wanting. Eye stalks short, stout, constricted in the middle; the cornea dilated and the ophthalmic scales completely lacking.

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[1] Contribution from the Allan Hancock Foundation. Received March 24, 1950.

Antennal acicle narrow, triangular, and reduced. Second and third pereiopods exceeding chelipeds in length. Tail fan symmetrical, telson not divided by sulci, uropods without scabrous pavement of corneous granules.

Description.—Chelipeds equal, similar, smooth, with only a few scattered setae. Lateral margins slightly swollen, with the widest point approximately at the middle of the palm. Fingers acuminate, short, about one fourth the total length of the manus. Carpus about one-third the length of the manus, narrow proximally, but flaring to approximately width of manus distally. Anteromedial corner produced into a blunt tubercle. Merus twice the length of carpus, with no distinct crest.

External maxillipeds noncheliform and flagellate.

Precervical portion of carapace slightly longer than wide, transversely convex, more coriaceous than calcareous. Rostral point broadly triangular with apex truncate, not extending beyond coxal segment of eye stalks, lateral points lacking. Postcervical region divided into a leathery median plate which narrows sharply posteriorly, and two larger lateral plates which become more membranous laterally.

Eye stalks short, terete, stout, and constricted in the middle; the cornea well developed and dilated. The ophthalmic scales are completely wanting, exposing the coxal articulation of the eye stalk.

Antennal acicle narrowly triangular, convex, and very short, extending only one half the length of the eye stalk; lightly setose and with entire margins. Antennal peduncle longer than the eye stalk when extended, exceeding it by the length of the very short fourth, and fifth, articles; flagellum with only a few scattered setae, and exceeding the reach of the chelipeds by one third its length.

Antennular peduncle longer than the eye, exceeding it for one third the length of the terminal peduncular article; flagellum consisting of approximately 12 annulations and densely setose beneath.

Second and third thoracic legs a little longer than the chelipeds, compressed, not crested, and with the exception of the dactyls, very sparsely setose. Dactyl curved, subequal to the propodus in length, and terminating in a sharp, horny claw. Fourth thoracic appendage subcheliform. Anterior face of the coxae of the fifth pair, which are cheliform, produced into low cone-shaped tubercles bearing the male genital pores.

Abdominal terga distinct and symmetrical, with the first and last smaller. There are no pleura, and on the ventral surface the somites are distinguishable only by very slight constrictions. Abdominal appendages biramous; the posterior blade being reduced in all four pairs, which are practically of uniform size.

Telson symmetrical, spade shaped, unmarked by sulci, with eighteen heavy, evenly spaced setae along the distal margin. Uropods large, both blades flattened and membranous, the posterior blade the smaller, both with serrate, setose margins, and completely lacking a scabrous surface.

Measurements.—Total length (rostral point to tip of abdomen) 11 mm; length of carapace 5 mm; length of precervical region 2.75 mm; width of precervical region 2.25 mm; length of manus 3 mm; length of fingers 0.75 mm; length of carpus 1 mm; length of dactyl, second thoracic leg 2 mm; length of propodus, second thoracic leg 2.5 mm; length of telson 1.75 mm.

Distribution.—Gulf of California at Ensenada de San Francisco, Sonora, and Southwest Cove of San Francisco Island, Baja California.

Discussion.—A comparison of this species with *P. scorpio* (Alcock), heretofore the sole species in the genus, reveals some differences in characteristics that usually would be considered generic, rather than specific. The most obvious of these is the reduction in the number of pleopods, the specimen before me having but four pairs instead of five, as in *P. scorpio*. Likewise the complete absence of ophthalmic scales and the scabrous area of the uropods would also be in this category, since presence or absence of structures has been considered generic characters, while differences in degree or manner of possession constitute specific characters. The variation in the number of pleopods within a genus has a precedent, however, the male of *Pagurus variabilis* (Milne-Edwards and Bouvier) having three, instead of the usual four pleopods. Also the general proportions, the nonoperculiform nature of chelipeds, the noncheliform external maxillipeds, which are approximated at the base, the telson not marked by sulci, and the twelve pair of branchiae make this form identifiable as *Parapylocheles*.

Though a notation of the small, poorly developed eye of *P. scorpio* is given in the generic description by Alcock, this characteristic is one of degree and should not by itself be considered of generic importance; thus the possession of robust, well-developed eyes by *P. glasselli* would not forego its inclusion in the genus. A case in point is shown within this small family when the genus *Chiroplataea* was separated from *Pylocheles* on the basis of this character by Spence-Bate. Alcock himself (1905) and Milne-Edwards and Bouvier all agree that in spite of the lack of well-developed eyes *Chiroplataea* should be considered synonymous with *Pylocheles*.

Thus, while the differences between *P. glasselli* and the genotype seem to be as great as those between *P. scorpio* and other genera such as *Pylocheles* or *Mixtopagurus*, the writer feels that there would be little merit in erecting a new genus, even if these suppressions prove to be constant when more specimens are obtained.

Remarks.—This species is named for the late Steve A. Glassell, who has made many significant contributions to the knowledge of the decapod fauna of Pacific waters.

This constitutes the first record from American Pacific waters of this small and interesting family, as well as for the genus.

Family PAGURIDAE Dana, 1852

Genus **Xylopagurus** Milne-Edwards, 1880

Xylopagurus cancellarius, n. sp.

Fig. 2

Type.—Female holotype, U. S. N. M. no. 90384, from off Port Utria, Colombia, in 20 fathoms; collected by the *Velero III*, February 15, 1934, at station 238–34.

Paratype.—Male, A. H. F. no. 343, collected with the holotype.

Diagnosis.—Ophthalmic scales narrow, constricted in the center, rounded distally with 9 or 10 upward-curving spines on the distal margin. Dorsal surface of carpus of large cheliped with a strongly raised median ridge, which extends slightly beyond anterior margin of carpus; proximal margin of manus notched to receive it. Fifth thoracic legs subcheliform. Abdominal shield with four prominent conical tubercles, one pair just anterior, and the other just posterior to a central pitlike depression; not marked by discreet longitudinal sulcus.

Description.—Chelipeds unequal, dissimilar, the right vastly larger. Inner margin of manus prolonged into a triangular tubercle two-thirds as large as immovable finger; fingers strongly curved, occluding only at tips, moderately setose. Palm laterally convex throughout the proximal half of its length, concave at the base of the fingers, the distal two-thirds covered with conical granules, the proximal one third smooth. Lateral margins of the palm subparallel, setose, and the proximal dorsal margin notched to receive the carpal crest. Carpus triangular in cross section, with the apex the prominent dorsal crest; merus as long as carpus, crest less well developed.

Minor cheliped very weak, less than one-third the width of the large cheliped and reaching only to the distal edge of the carpus of the major hand. Palm subcylindrical, smooth, lightly setose; carpus cylindrical, smooth, not crested.

External maxillipeds not approximated at base, the biarticulate ischium large, with dorsomedian margin serrate, and a conspicuous curved spine on the medial surface. All three pairs flagellate.

Precervical portion of carapace longer than wide, smooth, well calcified, strongly convex. Rostral point triangular, acute, lateral points angular, reduced, extending only to base of rostral point. Postcervical portion with well calcified median plate and lateral plates becoming membranous marginally.

Eye stalks are stout, widening distally; the ophthalmic scales small, directed medially, narrow, constricted in the center, rounded distally, with 9 or 10 upward-curving spines on the distal margin.

Antennal acicle very much reduced, extending no farther than do the eye scales, very narrow, with serrate distal margin; antennal peduncle reaching only to base of cornea when extended. Flagellum setose and short, not exceeding the large cheliped in length.

Second and third thoracic legs compressed, smooth, polished, and reaching beyond the base of the fingers of the major cheliped. Dactyl only sparsely setose and equal in length to propodus. Coxae of the third pair bearing the prominent circular genital openings on the ventral surface. Fourth pair subcheliform and having the distinctive large oval rasp as in *X. rectus*; the fifth pair having the movable finger so reduced as to be almost vestigial resulting in a subcheliform condition.

Abdominal terga weakly calcified, asymmetrical, larger on the left side, and not in contact with one another. Abdominal appendages unequally biramous, posterior blade being larger.

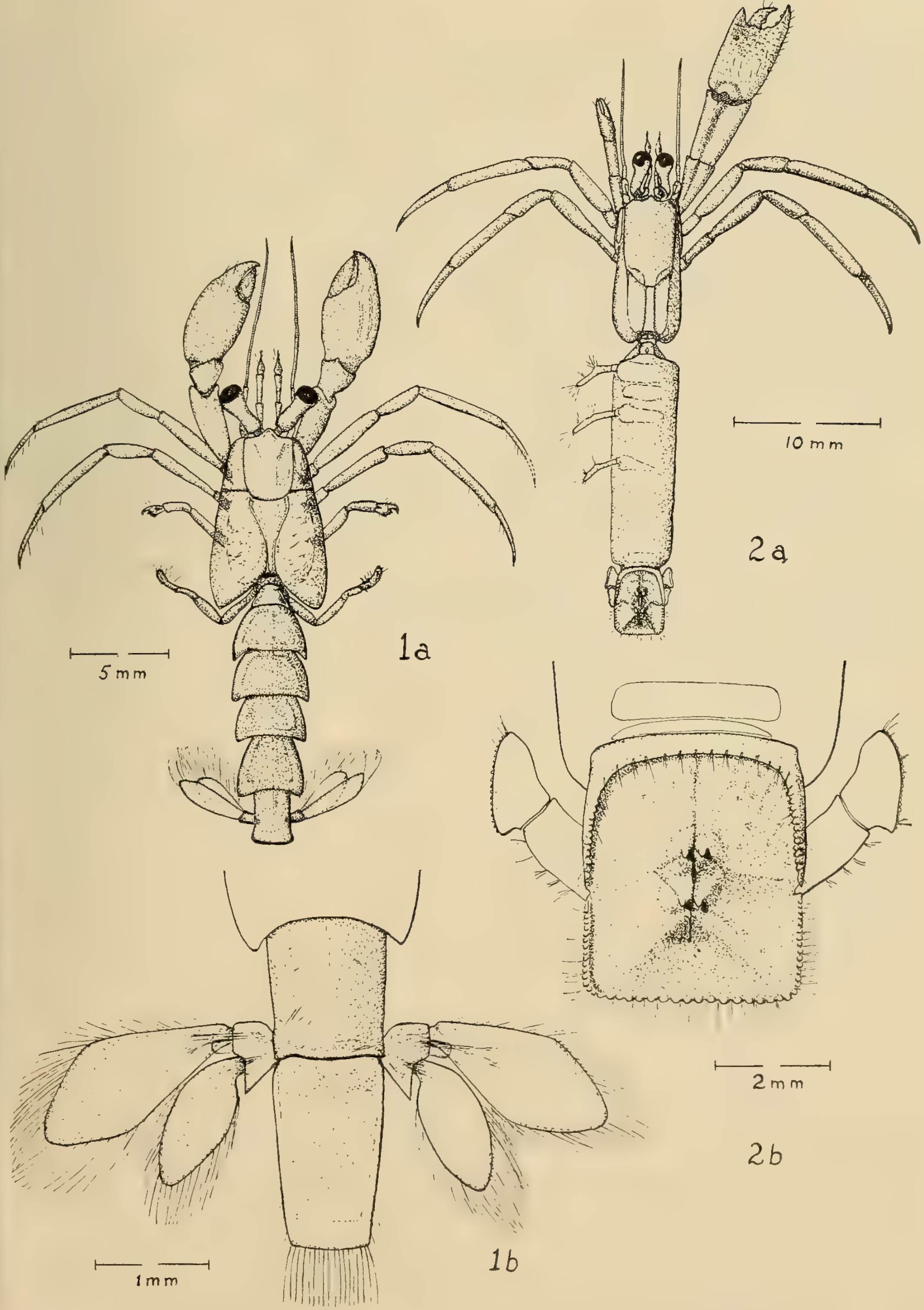

Fig. 1.—*Parapylocheles glasselli*, n. sp.: *a*, Dorsal view; *b*, extended tail fan, dorsal view.
Fig. 2.—*Xylopagurus cancellarius*, n. sp.: *a*, Dorsal view; *b*, Caudal "shield," dorsal view.

The conspicuous caudal "shield," a modification to form an operculum to close the posterior opening of the vegetable tube inhabited by the animal, is the distinctive mark of the genus. In this species it is strongly calcified, roughly quadrangular, and apparently formed by the fusion of the two posterior terga. There is a raised margin around the entire perimeter except for a notch marking the line of fusion of the two plates; lateral and distal margins composed of regular, rounded granules, each separated by a rounded sinus in which there is a tuft of setae. Proximal margin merely a raised ridge with regularly spaced fascicles of setae. In the center of the shield are two pairs of prominent conical tubercles, one pair just anterior, and one pair posterior, to the line of fusion of the component terga.

The telson is very much reduced, though well calcified, and is carried flexed forward so it lies flat against the abdomen. The exposed ventral (actually dorsal) surface is marked by a central and two deeper lateral pits, while the terminal margin is spinulose. The uropodal peduncle is well calcified, and the outer surfaces of the blades are covered with conical spines rather than the low rounded granules found in most pagurids.

Measurements.—Total length (rostral point to tip of abdomen) 34 mm; length of carapace 10 mm; length of precervical region 4 mm; length of major manus 7 mm; length of movable finger 2 mm; width of manus 3.5 mm; length of carpus 3.5 mm; length of minor manus 4 mm; width of minor manus 1 mm; length of dactyl second thoracic leg 4.5 mm; length of propodus 5 mm; length of caudal shield 5 mm; width of caudal shield 3.5 mm.

Distribution.—Known only from the type locality, off Port Utria, Colombia, at station no. 238-34.

Discussion.—This species is very closely allied to *Xylopagurus rectus* Milne-Edwards and resembles it quite closely, although the two species can be differentiated very readily by cursory inspection of the caudal shield because the ornamentation is quite different.

Remarks.—*X. cancellarius* evidently has much the same habits as its relative on the opposite side of the Isthmus of Panama, as it was taken wedged tightly into a hollow reed, *Typha* sp., as is usual in the Caribbean species.

Genus **Aniculus** Dana, 1852

Aniculus elegans Stimpson, 1859

Aniculus elegans Stimpson, Ann. Lyc. Nat. Hist. New York **8:** 83. 1859.
Aniculus longitarsus Streets, Proc. Acad. Nat. Sci. Philadelphia **23:** 240. 1871.
Aniculus elegans Stimpson, Bouvier, Bull. Mus. Hist. Nat. Paris **1:** 8. 1895.
Aniculus elegans Stimpson, Boone, Bull. Amer. Mus. Nat. Hist. **63:** 140, fig. 1. 1931.

Type.—Stimpson's type, which was collected at Panama by the Rev. J. Rowell, is believed to have been destroyed in the Chicago fire of 1871.

Neotype.—A female neotype, A. H. F. no. 394, is here designated. This specimen was collected at Taboga Island, station 959-39, May 2, 1939, by the *Velero III.*

Description.—Chelipeds similar, equal, fingers spooned, tipped with horny black hooves, movable finger almost half the total length of manus, carpus trigonal, as wide as manus distally; the underside of both carpus and merus setose, but not tuberculated as in *A. aniculus.*

Third maxillipeds approximated at base, all three pairs flagellate.

Precervical portion of the carapace shield-shaped, slightly longer than wide. *Frontal margin with angular lateral points three-fourths as long as rostral point,* which is marked by two deep circular pits. *Median areolet of gastric region a complete rhomboid,* with the two anterior sides longest and straightest.

Postcervical region coriaceous, widening posteriorly, with the narrow median area defined by an elongate, tonguelike calcareous plate.

Eye stalks slender, cylindrical, expanded at the base and at the base of the cornea. Ophthalmic scales in the shape of a right triangle, the hypotenuse facing laterally. Antennal acicle a narrow acute triangle, *its apex reaching one-half the length of the cylindrical third peduncular article,* which reaches two-thirds the length of the eye stalk. Flagellum short, barely reaching tips of chelipeds, and naked.

Both the second and the third thoracic legs exceed the chelipeds in length, the dactyl being longer than the related propodus in each case. On the meral joint the transverse scutes are interrupted on the dorsal surface, the entire inside surface being smooth and polished. *On the carpus the scutes extend over the dorsal one-half of the* *medial surface, the ventral-medial surface being smooth.* Propodus completely ringed by the scutae. Abdomen soft, only slightly coiled, terga ciliated, lobed, not in contact with one another.

Measurements.—The following measurements are for the largest specimen, a male of approximately the same size as Stimpson's type (5 inches). Total length (rostral point to tip of abdomen) 80 mm; length of carapace 41 mm; length of precervical portion 20 mm; width of precervical portion 17 mm; length of manus 23 mm; length of movable finger 11 mm; length of carpus 12 mm; length of dactyl of third thoracic leg 19 mm; propodus third thoracic leg 16 mm; length of telson (including plate) 14 mm.

Distribution.—Boone (1931) states that *A. elegans* was previously known only from West Panama and the Pearl Islands, though E. L. Bouvier (1895) in a list of species of the Diguet collection lists this form with the Baja California fauna. No locality data other than that in the title are given, however, but in a paper by Hariot (1895) on the algal collection of Diguet, made at the same time, the localities given were almost without exception from the pearl dredgings at La Paz. To support this assumption further, among the new species of decapods described by Bouvier in this paper was *Eiconaxius vivesi* "*(dediée a M. Vives, sur le désir de M. Diguet).*" Since Señor G. J. Vives was an official of the Mexican Government at La Paz, and this would be within the normal expected range of a Panamic species, the writer feels it is quite logical to accept this as a record of this species from La Paz.

In the series of six specimens in the Hancock collections are two specimens from Acapulco, Mexico; one from the Tres Marías Islands, Mexico; one from Taboga Island, Panama; one from Secas Islands, Panama; and one from off Cape San Francisco, Ecuador, which represents a southward extension of range.

Two specimens were taken in the intertidal zone, three 2–5 fathoms, and the one from Ecuador in 15 fathoms.

Remarks.—A detailed comparison of the specimens in the Hancock collections with Boone's description in the above-mentioned paper disclosed discrepancies in several characteristics that would lead one to believe that the description was of a species distinct from *A. elegans* since it failed to check not only with these specimens, but also at least in one particular, with Stimpson's and Street's original descriptions.

Through the courtesy of John C. Armstrong, of the American Museum of Natural History, I was able to examine the specimens described by Boone and found that they are *Aniculus elegans* Stimpson. To forestall the possibility of other workers being misled, as was the writer, the species has here been very briefly redescribed and the characteristics not agreeing with Boone's description given in italics.

It seems notable that such a large and conspicuously colored animal could be so consistently missed by collectors in the intertidal zone. It is possible that this form is as obscure as it is rare. Yap-Chiongco (1938) reports that a very closely related species, *Aniculus aniculus* (Fabricius), is fossorial, as this species might well be, which would help to account for its rarity in collections.

One specimen from Acapulco was collected by Dr. Carl L. Hubbs; the other from the same locality by Dr. E. Yale Dawson; and the others in the series were dredged by the *Velero III*.

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ZOOLOGY.—*A new crayfish of the genus* Procambarus *from Oklahoma and Arkansas (Decapoda, Astacidae).*[1] HORTON H. HOBBS, Jr., Miller School of Biology, University of Virginia. (Communicated by F. A. CHACE, Jr.)

The new crayfish herein described was collected from two localities in the headwaters of Little River in Oklahoma and Arkansas by Dr. Charles E. Burt on June 3, 1934, and the specimens were deposited in the collection of the United States National Museum.

Only three species of the genus *Procambarus* [*P. simulans* (Faxon, 1884: 112), *P. gracilis* (Bundy, 1876: 5), and *P. blandingii acutus* (Girard, 1852: 91)] were reported to occur in Oklahoma by Creaser and Ortenburger (1933), and with the addition of the new species described below, 12 species of crayfishes are now known to be present in the State.

No comprehensive survey of the crayfishes of Arkansas has been made; however, the following species of the genus *Procambarus* are known to occur within its political boundaries: *P. clarkii* (Girard, 1852: 91), *P. blandingii acutus* (Girard), *P. gracilis* (Bundy), *P. simulans* (Faxon), and *P. viaeviridis* (Faxon, 1914: 370).

A key for the identification of the crayfishes of the genus *Procambarus* occurring in Oklahoma and Arkansas is included below.

I wish to express my appreciation to Dr. Burt for supplying me with the data for the specimens on which this new species is based.

Procambarus tenuis, n. sp.[2]

Diagnosis.—Rostrum without lateral spines and acumen indistinctly set off from basal portion; areola narrow with only two punctations in narrowest part; cephalothorax strongly compressed and bearing prominent setiferous punctations between which are crowded numerous smaller ones. Male with hooks on ischiopodites on third and fourth pereiopods; palm of chela of first form male not bearded but bearing a row of seven to nine tubercles along inner margin; postorbital ridges terminating cephalad without spines or tubercles; lateral surface of carapace without spines. First pleopod of first form male terminating in three distinct parts: the noncorneous mesial process thin, triangular, and directed caudally at almost a right angle to the main shaft of the appendage; the plate-like cephalic process, which is contiguous with the mesial one, extends caudodistad from the mesiodistal surface; the corneous central projection, the most prominent of the three terminal elements, arises from the lateral half of the distal end of the appendage, is somewhat compressed and tapering and directed distad and caudomesiad; caudal element represented by a slight knob at the caudolateral base of the central projection. Annulus ventralis with extremely high caudal wall (see Fig. 7).

Holotypic male, form I.—Body ovate, strongly compressed laterally; abdomen narrower than thorax (9.9–10.8 mm in widest parts respectively); width of carapace less than depth in region of caudodorsal margin of cervical groove (10.8–11.5 mm).

Areola narrow, about 16 times longer than broad with two rows of punctations in narrowest part; cephalic section of carapace about 2.3 times as long as areola (length of areola about 30.4 percent of entire length of carapace).

Margins of rostrum converging cephalad to a small corneous upturned apical tubercle; margins somewhat swollen and subtended mesially by a row of setiferous punctations; concave upper surface with a few similar scattered punctations.

Postorbital ridges deeply grooved laterad and terminating cephalad bluntly; subrostral ridges weak and evident in dorsal aspect for only a short distance at base of rostrum; suborbital angle obtuse; branchiostegal spine small and blunt; sides of carapace without spines or tubercles. Surface of carapace punctate except along cephaloventral margin where it is granulate.

Abdomen slightly shorter than thorax (25.9–26.6 mm).

Cephalic section of telson with two spines in each caudolateral corner.

Epistome subtrapezoidal in outline with a small cephalomedian projection; cephalolateral portions inflated.

Antennules with the usual small spine on ventral surface of basal segment.

Antennae extend caudad to sixth abdominal

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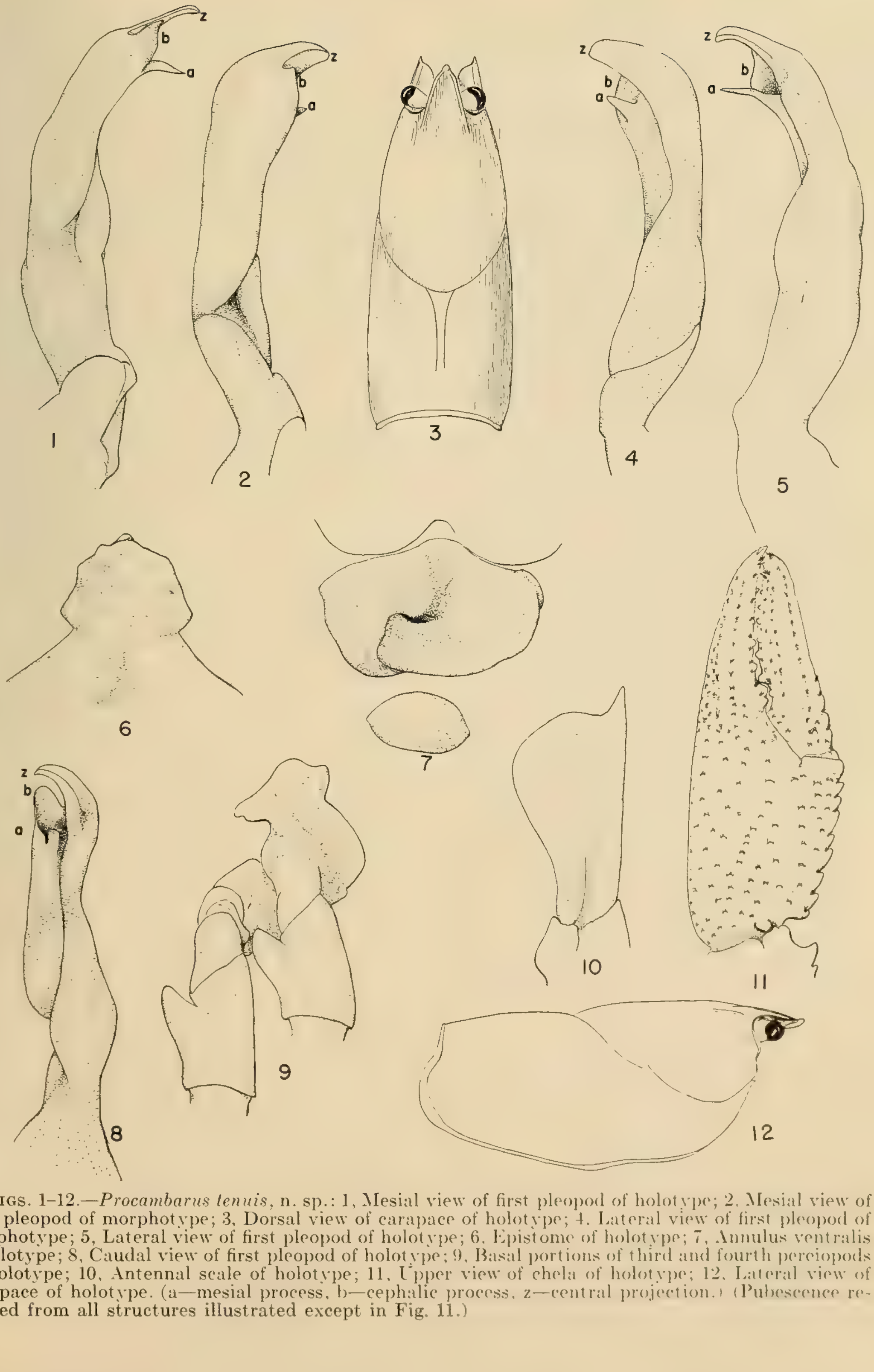
[1] Received March 24, 1950.

[2] The name *tenuis* refers to the slender (compressed) carapace.



Figs. 1–12.—*Procambarus tenuis*, n. sp.: 1, Mesial view of first pleopod of holotype; 2, Mesial view of first pleopod of morphotype; 3, Dorsal view of carapace of holotype; 4, Lateral view of first pleopod of morphotype; 5, Lateral view of first pleopod of holotype; 6, Epistome of holotype; 7, Annulus ventralis of allotype; 8, Caudal view of first pleopod of holotype; 9, Basal portions of third and fourth pereiopods of holotype; 10, Antennal scale of holotype; 11, Upper view of chela of holotype; 12, Lateral view of carapace of holotype. (a—mesial process, b—cephalic process, z—central projection.) (Pubescence removed from all structures illustrated except in Fig. 11.)

segment; antennal scale broad with a well developed spine on outer distal margin; lamellar portion with rounded inner margin and broadest distad of middle (Fig. 10).

Left chela (right lacking) moderately heavy (Fig. 11); palm slightly inflated and studded with setiferous squamous tubercles on upper surface. Inner margin of palm with a row of eight prominent tubercles and a few squamous ones subtending this row above and below. Lower surface of palm with setiferous punctations except near base of immovable finger where punctations give way to setiferous squamous tubercles; a prominent corneous-tipped tubercle present at base of movable finger. Fingers only slightly gaping. Opposable margin of dactyl with six evenly spaced rounded tubercles along basal two-thirds, the proximal three larger than the distal ones, and the second distinctly larger than the first; distad of and between these tubercles are crowded minute denticles; upper surface with a submedian longitudinal ridge flanked on each side by a row of setiferous punctations, and in addition bearing a few squamous tubercles near base and scattered punctations laterad of the ridge; lower surface of dactyl similar to upper surface; lateral margin of dactyl with a row of three tubercles on basal third, distad of which is a row of setiferous punctations. Opposable margin of immovable finger with five tubercles along basal three-fifths and an additional one on lower opposable margin at base of distal fourth, the proximal four larger than the distal two, and the proximal two contiguous; a row of minute denticles between and distad of this row of tubercles; other surfaces as described for dactyl.

Carpus of first left pereiopod about 1.6 times longer than broad with a shallow oblique furrow above; surface laterad of furrow punctate; that mesiad of it with a row of setiferous punctations, and mesiad of the latter a row of four small tubercles; mesial surface of carpus with seven tubercles, four of which are evident in upper aspect and progressively larger distad; lower mesial margin with a row of five tubercles, the distomarginal one decidedly larger than others; lateral surface of carpus with setiferous punctations and a prominent tubercle on lower distal angle.

Merus of first left pereiopod with a row of 16 tubercles on upper margin and with a few additional ones flanking this row distally; lateral and mesial surfaces with setiferous punctations; lower surface with a lateral row of nine spikelike tubercles and a mesial one of 14, and an additional tubercle present between the distal members of these two rows.

Ischiopodites of third and fourth pereiopods with hooks; hooks simple and concave proximad. Coxopodites of fourth and fifth pereiopods with ventrally projecting prominences, those on fourth large, complex, and with a prominent cephalomedian extension; those on fifth small, slender, and subacute.

First pleopod reaching coxopodite of third pereiopod when abdomen is flexed; pleopods symmetrical, their cephalic surfaces convex and without a prominent hump. (See description of pleopod under Diagnosis.)

Morphotypic male, form II.—Differs from the holotype in the following respects: in the absence of suborbital angles and a few very slight differences in tubercle counts; the usual secondary sexual differences occur, however, all terminals of first pleopods except caudal element evident.

Allotypic female.—Differs from the holotype in the following respects: Branchiostegal spines well defined and acute; suborbital angles almost obsolete. Opposable margin of dactyl with seven tubercles on basal four-fifths, the second, third and fourth from base largest, the second so distinctly larger than the first that a distinct emargination occurs immediately proximad of the former with the basal tubercle in the emargination; mesial surface of dactyl with only two proximal tubercles; opposable margin of immovable finger with only four tubercles on basal three-fifths; armature of merus and carpus reduced both in number and size of tubercles.

Annulus ventralis subovate in outline with the greatest length in the transverse axis; caudal and dextral walls high; central area with a broad, shallow funnellike depression. Sinus originates in subcentral depression and crosses caudal wall distinctly dextrad of median line (see Fig. 7).

Measurements.—As follows (in millimeters):

	Holotype	*Allotype*	*Morphotype*
Carapace—height	11.5	11.4	11.2
width	10.8	9.4	9.5
length	25.6	24.0	24.7
Areola—length	9.0	8.5	9.1
width	0.5	0.5	0.6
Rostrum—length	4.5	3.9	4.2
width	4.0	3.2	3.5
Left chela—length, inner margin of palm	9.2	7.0	7.3
width of palm	8.9	8.3	8.5
length, outer margin of hand	23.2	17.0	19.3
length of dactyl	13.2	10.1	10.8

Type locality.—"Six miles east of Page and just west of Oklahoma state line, Le Flore Co., Oklahoma. In spring at base of 'mountains'," a tributary of the Little River.

Disposition of types.—The holotypic male, form I, allotypic female, and morphotypic male are in the United States National Museum (no. 90390). Of the 23 paratypes, one male, form I, one male, form II, and one female are in my personal collection at the University of Virginia (no. 6-334-1); one male, form I, five males, form II, five females, four immature males, and five immature females are in the United States National Museum (nos. 90391, 90392).

Specimens examined.—All specimens collected on June 3, 1934, by Charles E. Burt. From the type locality: 3♂♂I, 6♂♂II, 4♀♀, 2♂♂ imm., and 4♀♀ imm. From 6 miles northwest of Rich Mountain, Polk County, Ark., just east of state line: 1♂II, 3♀♀, 2♂♂ imm., 1♀ imm. Both of these localities are on tributaries of the Little River.

Variations.—Except for the differences pointed out in the above descriptions the variations among the specimens at hand are minor ones. In the females mirrored images of the annulus ventralis of that figured for the allotype occur.

Relationships.—*Procambarus tenuis* is a somewhat disjunct member of the genus *Procambarus.* Although its affinities appear to be with the members of the *Blandingii* section (see Hobbs, 1942: 93) the cephalic process of the first pleopod of the male arises from the mesial surface of the appendage, and under the cited definition this would exclude *tenuis* from this section of the genus; furthermore, it does not conform to the definitions of any of the other sections. In the practically obsolete caudal process of the first pleopod *tenuis* approaches *Paracambarus paradoxus* (Ortmann, 1906: 3)[3]; also in the latter species the cephalic process arises from the mesial side of the appendage although it is not nearly so strongly developed as that in *tenuis*. There is little reason to believe that these resemblances actually indicate close affinities, for except for these features the pleopods of the two species are distinctly different. It is more probable that *tenuis* is more closely allied to *Procambarus blandingii acutus* (Girard, 1852: 91) than to any other described species.

KEY TO THE CRAYFISHES OF THE GENUS PROCAMBARUS IN OKLAHOMA AND ARKANSAS

1. Areola obliterated at least in middle........ 2
Areola broad or narrow but never obliterated. 3
2. Outer half of upper surface of palm of chela tuberculate above; movable finger without an excision on opposable margin near base; acumen distinctly set off from remainder of rostrum; suborbital angle not well defined; ischiopodites of third and fourth pereiopods in male bearing hooks; annulus ventralis without tubercles on cephalic half. . *clarkii*
Outer half of upper surface of palm of chela punctate above; movable finger with a distinct excision on opposable margin near base; acumen not distinctly set-off from remainder of rostrum; suborbital angle well defined; male with ischiopodites of third pereiopods only bearing hooks; annulus ventralis bearing tubercles on cephalic half. . *gracilis*
3. Acumen distinctly set off from base of rostrum. *blandingii acutus*
Acumen absent or not clearly set off from base of rostrum.................. 4
4. Males.................................. 5
Females................................ 7
5. Hooks on ischiopodites of third pereiopods only. *simulans*
Hooks on ischiopodites of third and fourth pereiopods.......................... 6
6. Carapace strongly compressed; central projection of first pleopod distinctly longer than other terminal elements.............. *tenuis*
Carapace not markedly compressed; central projection of first pleopod not longer than other terminal elements........ *viae-viridis*
7. Annulus ventralis with longitudinal ridges in cephalic half bearing tubercles...... *simulans*
Annulus ventralis without longitudinal ridges bearing tubercles.......................... 8
8. Caudal wall of annulus ventralis high, and with a distinct median depression; sinus cuts caudal wall distinctly to right or left of median line of annulus ventralis.............. *tenuis*
Caudomedian wall of annulus ventralis low, but with a high cephalic wall bearing a median cleft; sinus cuts caudal wall near median line of annulus ventralis........ *viae-viridis*

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[3] Redescribed and carefully figured by Villalobos 1947: 233 (see pl. 3, fig. 1).

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PROCEEDINGS OF THE ACADEMY

52D ANNUAL MEETING

The 52d Annual Meeting, concurrently with the 369th monthly meeting of the Academy, was held as a dinner meeting in the Palm Room of Hotel 2400 on January 28, 1950, at 6:30 P.M. President F. H. H. Roberts, Jr., presided.

After the dinner, Dr. Roberts called the meeting to order and introduced the speaker, Herbert Friedmann. Dr. Friedmann gave an illustrated talk dealing with the symbolism portrayed on two of the Medici tombs by Michelangelo. He analyzed the use of an owl and a wild cat to show Michelangelo's subtle interpretation of some aspects of the Medici family on the monumental tombs he created for two of the Medici.

The minutes of the 51st Annual Meeting were approved as published in the Journal **39:** 206–213. 1949.

The following reports by the various officers, standing committee chairmen, auditors, and tellers were read and accepted:

REPORT OF THE SECRETARY

During the Academy year, January 22, 1949, to January 28, 1950, there were 56 persons elected to regular membership, including 50 to resident and 6 to nonresident. Of these, 38 resident and 5 nonresident qualified for membership. Eight resident members and one nonresident member elected to membership in the preceding Academy year qualified during the present Academy year just ending. The new members were distributed among the various sciences as follows: 14 in chemistry, 6 each in mathematics and physics, 5 in plant pathology, 4 each in geology and geophysics, 2 each in archeology, bacteriology, engineering, medicine, and physiology, and 1 each in biochemistry, botany, conservation, genetics, ichthyology, mechanical engineering, and natural history.

Five resident and three nonresident members, having retired from the gainful practice of their professions, were placed on the retired list of members to enjoy all the privileges of active membership without further payment of dues. Eight resident members and three nonresident members resigned in good standing.

The deaths of the following members were reported to the Secretary:

Carl F. A. Christensen, Copenhagen, Denmark, on November 24, 1942.

George Tully Vaughan, Washington, D. C., on April 26, 1948.

Edward R. Stitt, Washington, D. C., on November 13, 1948.

Stephen R. Capps, Washington, D. C., on January 19, 1949.

S. H. McCrory, Washington, D. C., on February 18, 1949.

Bailey Willis, Stanford University, Calif., on February 19, 1949.

Samuel F. Hildebrand, Washington, D. C., on March 16, 1949.

George B. Richardson, Washington, D. C., on March 18, 1949.

William B. Bell, Washington, D. C., on March 30, 1949.

Joseph A. Cushman, Sharon, Mass., on April 16, 1949.

Whitman Cross, Chevy Chase, Md., on April 20, 1949.

O. F. Cook, Washington, D. C., on April 23, 1949.

Philip S. Smith, Washington, D. C., on May 10, 1949.

Alfred P. D. Stokes, Riverside, Calif., on May 17, 1949.

John M. Cooper, Washington, D. C., on May 22, 1949.

Sigurd Orla-Jensen, Copenhagen, Denmark, on June 24, 1949.

H. M. Goodwin, Cambridge, Mass., on June 26, 1949.

Charles J. Brand, Washington, D. C., on June 29, 1949.

P. G. Nutting, Washington, D. C., on August 8, 1949.
Frank E. A. Thone, Washington, D. C., on August 25, 1949.
William J. Rooney, Washington, D. C., on August 31, 1949.
William J. Humphreys, Washington, D. C., on November 10, 1949.
John Tucker, Jr., Washington, D. C., on November 20, 1949.
H. C. Dickinson, Washington, D. C., on November 27, 1949.
Alfred J. Lotka, Red Bank, N. J., on December 5, 1949.
Charles J. Clifford, Silver Spring, Md., on December 21, 1949.
Clarence N. Fenner, Clifton, N. J., on December 24, 1949.

Carl F. A. Christensen, Edward R. Stitt, and Sigurd Orla-Jensen were honorary members, and Bailey Willis, Whitman Cross, and O. F. Cook were original members.

On January 28, 1950, the status of membership was as follows:

	Regular	*Retired*	*Honorary*	*Patron*	*Total*
Resident	515	50	1	0	566
Nonresident	159	33	12	0	204
Total	674	83	13	0	770

The net changes in membership during the past year are as follows:

	Regular	*Retired*	*Honorary*	*Patron*	*Total*
Resident	+17	−5	−1	0	+11
Nonresident	+4	+3	−2	0	+5
	+21	−2	−3	0	+16

During the Academy year 1949 the Board of Managers held 10 meetings, with an average attendance of 20 persons. The following important matters were considered by the Board:

Owing to previous financial commitments, the Board of Managers endeavored to limit all operations of the Academy within the budget of the current year. Numerous suggestions were considered whereby additional income might be forthcoming. At the February 14 meeting of the Board, the Executive Committee submitted the 1949 budget, which indicated a decrease in net worth of over $4,000. The Board therefore voted to place the matter of how the Academy might recover some of this decrease in the hands of the Committee on Policy and Planning.

At the 429th meeting of the Board, on June 13, the Committee on Policy and Planning, under the chairmanship of John E. Graf, submitted a 13-page mimeographed report entitled "Means of Raising Additional Funds for the Academy." Each member of the Board received a copy to study, and this report was then discussed at the next meeting of the Board. Fourteen specific items covering all the activities of the Academy, as well as consideration of new activities, were outlined by the Committee and discussed by the Board.

Action was taken on three important items:

1. That the President meet with the Committee on Membership in order to discuss problems confronting this committee. This action resulted in the appointment by the President of five subcommitteemen within as many agencies to assist the main Committee on Membership by submitting to them the names of qualified scientists for consideration as future members of the Academy.

2. The Chairman of the Committee on Policy and Planning indicated that as a result of conferring with editors of other scientific journals, we could expect only a slight income if the Journal were to accept advertising.

3. Some consideration was given to the size of the Journal. The Board requested the President to appoint a committee to consider the possible saving that might result by the use of an offset printing method, as well as the formulation of an editorial policy. This committee, appointed on November 14, 1949, has not submitted a report.

Two of the regular monthly meetings of the Academy were held jointly with the Biological and Entomological Societies of Washington and were exceptionally well attended by over 400 people at each joint meeting. These were entitled *The language of bees*, by Karl von Frisch, of Austria, and *Ngana, African sleeping sickness of animals*, by H. H. Stage, of the U. S. Department of Agriculture.

The Academy continued to sponsor the weekly issue of the Science Calendar in the local newspapers.

During the Academy year, eight meetings of the Academy were held, as follows:

On February 17, 1949, F. D. Rossini, National Bureau of Standards, delivered his retiring presidential address, on *Excursion in chemical thermodynamics*, published in the Journal **39**: 249–269.

On March 17, 1949, the 1948 *Academy Awards* were presented to Robert J. Huebner, National Institutes of Health, for work in the biological sciences; to Maxwell K. Goldstein, Office of Naval Research, for work in the engineering sciences; and to J. A. Van Allen, Johns Hopkins University Applied Physics Laboratory, for work in the physical sciences. The Academy awarded for the first time *Certificates of Merit* to seven outstanding local high-school science students: Walter Gilbert, Sidwell Friends School; Carl Weber Werntz, Calvin Coolidge High School; Agnes Scott Preston, Dunbar High School; John Richard McGonegal, St.Anselm's Priory High School; Ellen Mae MacEwen, Woodrow Wilson High School; Charles Edward Weir, Dunbar High School; and William Stanton Shipley, Woodrow Wilson High School.

On April 15, 1949, Karl von Frisch, University of Graz, Austria, addressed a joint meeting of the Academy and the Biological and Entomological Societies of Washington on *The language of bees.*

On May 19, 1949, Wilmot H. Bradley, U. S. Geological Survey, addressed the Academy on *Limnology and the Eocene lakes of the Rocky Mountains.*

On October 6, 1949, H. H. Stage, Bureau of Entomology and Plant Quarantine, addressed a joint meeting of the Academy and the Biological and Entomological Societies of Washington on *Ngana, African sleeping sickness of animals, transmitted by tsetse flies.*

On November 17, 1949, Newbern Smith, National Bureau of Standards, addressed the Academy on *Technical developments in the field of color television.*

On December 15, 1949, David Edward Davis, Johns Hopkins University, addressed the Academy on *Population and other ecological studies on rats in relation to city sanitation and public health.*

On January 28, 1950, Herbert Friedmann, U. S. National Museum, gave an after-dinner talk to the Academy on *The owl and the pussy cat.*

Five of the meetings were held in the Cosmos Club. The two joint meetings with the Biological and Entomological Societies of Washington, on April 15 and October 6, 1949, were held in the auditorium of the U. S. National Museum. The meeting on January 28, 1950, was held in the Hotel 2400.

Frank M. Setzler.

REPORT OF THE TREASURER

The Treasurer submits the following report concerning the finances of the Washington Academy of Sciences for the year ended December 31, 1949:

RECEIPTS

Dues, 1947	$18.00	
1948	151.00	
1949	3,611.75	
1950	76.00	$3,856.75
Journal,		
Subscriptions,		
1947	15.50	
1948	35.25	
1949	862.92	
1950	826.45	
1951	3.38	1,743.50
Reprints,		
1947	32.30	
1948	321.92	
1949	658.60	1,012.82
Sales,		
1949		987.61
Interest & Dividends		975.00
Directory (33d ed.)		13.12
Monograph no. 1		265.82
Transferred from invested funds		3,000.00
Annual dinner		392.00
A.A.A.S.		400.00
Postage refund		0.19
Redeposit of Debit no. 1344A		4.50
Overpayments		3.40
Total receipts, 1949		$12,654.71
Cash balance, Jan. 1, 1949		1,569.44
Total to be accounted for		$14,224.15

DISBURSEMENTS

	1948	*1949*	*Total*
Secretary's Office	$ 214.31	$ 438.71	$ 653.02
Treasurer's Office		208.64	208.64
Subscription Manager & Custodian	31.78	28.39	60.17
Meetings Committee	13.63	317.63	331.26
Membership Committee		15.51	15.51
Journal			
Printing & mailing	1,423.28	5,016.06	6,439.34
Illustrations	127.05	264.35	391.40
Reprints	225.28	508.71	733.99
Office			
Editorial Asst.	25.00	275.00	300.00
Miscellaneous	2.08	38.32	40.40
Annual dinner		339.50	339.50
Science Fair		100.00	100.00
Monograph no. 1		2,542.02	2,542.02
Grants-in-aid		400.00	400.00
Debit Memos:			
1288A... $10.00			
1295A... 7.50			
1344A... 4.50		22.00	22.00
Refunds		11.37	11.37
	$2,062.41	$10,526.21	$12,588.62
Cash book balance as of December 31, 1949			1,635.53
Total accounted for			$14,224.15

RECONCILIATION OF BANK BALANCE

Balance as per cash book, Dec. 31, 1949			$1,635.53
Balance as per Amer. Trust Co. statement of Dec. 30, 1949		$1,480.31	
Receipts undeposited		1,123.90	
Total		$2,604.21	
Checks outstanding, as of Dec. 31, 1949			
No. 1018	$ 5.41		
1263	5.00		
1354	150.00		
1355	250.00		
1357	2.50		
1358	414.13		
1359	126.50		
1360	15.14	968.68	$1,635.53

INVESTMENTS

Washington Sanitary Improvement Co.		
Certificate no. A 182—818 shares at $10		$8,180.00
Potomac Electric Power Co.		
Certificate no. TAO 1977—40 shares 3.6% pref. at $50		2,000.00
City of New York—3% (Transit Unification) Due—June 1, 1980		
Certificate No.		
D 20186	$500.00	
C 71038	100.00	
C 71039	100.00	
C 71040	100.00	800.00
First Federal Saving & Loan Ass'n.		
Investment account book		2,000.00
Northwestern Federal Savings & Loan Ass'n.		
Certificate No. 1380	$4,500.00	
1441	500.00	$5,000.00
United States Government		
Series G Bonds:		
No. M 332990 G	1,000.00	
M 332991 G	1,000.00	
M 332992 G	1,000.00	
M 332993 G	1,000.00	
M 1808741 G	1,000.00	
M 2226088 G	1,000.00	
M 2982748 G	1,000.00	
M 4126041 G	1,000.00	
M 5141346 G	1,000.00	
M 5141347 G	1,000.00	$10,000.00
American Security and Trust Co.		
Savings account		46.87
Total		$28,026.87
Cash balance Dec. 31, 1949		1,635.53
Total		$29,662.40

Total as of Dec. 31, 1948	$32,596.31
Total as of Dec. 31, 1949	29,662.40
Decrease	2,933.91

At the close of business on December 31, 1949, there were 33 members of the Academy who were in arrears, 20 for 1 year, 5 for 2 years, 7 for 3 years, and 1 for 4 years.

Howard S. Rappleye.

REPORT OF AUDITING COMMITTEE

The accounts of the Treasurer of the Washington Academy of Sciences for the year 1949 were examined by your auditing committee on January 18, 1950.

The accompanying copy of the Treasurer's report was checked and found to be in complete agreement with the records and with the cash balance of the Academy at the American Security & Trust Co. The bank deposits were found to check with the record of the receipts from all sources. All disbursements had been duly authorized and were found to be supported by vouchers and cancelled checks. The securities of the Academy were inspected and found to be in agreement with the list given in the Treasurer's report and to have all coupons attached that are not yet due.

Your auditing committee takes pleasure in commending Treasurer Howard S. Rappleye for the orderly way in which he has kept the accounts of the Academy.

N. F. Braaten.
C. V. Morton.
Lloyd G. Henbest, *Chairman.*

REPORT OF THE BOARD OF EDITORS

Volume 39 of the Journal, for the year 1948, contained 429 printed pages, 4 more than for the previous year but 19 less than for 1947. Because of a need to reduce the expenditures of the Academy, and because of uncertainty concerning the cost of publication with a new printer, the number of pages was held down, with the result that we came well within the budget allotment. Considerably fewer papers were published in 1949 than in 1948, and the papers in the biological sciences were proportionately more numerous than last year, possibly the result of there being two biologists on the editorial board. There were 43 papers in biology, 4 papers in the physical sciences, two of which were presidential addresses, and 10 papers in the social sciences. The proportions by pages were: Biological sciences, 58 per cent, of which 86 per cent were taxonomic; physical sciences, 14 per cent; social sciences, 16 per cent; Proceedings of the Academy and obituaries, 12 per cent. There were 19 obituaries in 1949 as against 3 for 1948.

The disbursements for the JOURNAL during 1949 were:

Printing, engraving, and mailing	$5,834.00
Reprints	834.53
Office—Editorial Assistant	300.00
Office—Miscellaneous	25.25
Total	$6,993.78
Charges to authors	979.94
Net cost of JOURNAL to Academy	$6,013.84

In 1948 the net cost to the Academy was $5,602.19. A 20-percent increase in cost was expected under the new printing rates, but this did not materialize.

This year the JOURNAL was printed by the Waverly Press, Inc., of Baltimore. The work of this press has proved very satisfactory on the whole. It is regretted that no issues have appeared on the fifteenth of the month and that two of them were more than three weeks late, but it is hoped that this condition can be improved in the future.

The Board of Editors wishes to acknowledge the cooperation of the Board of Managers and the officers of the Academy. Special thanks are due, as usual, to Mr. PAUL H. OEHSER who so ably handles the preparation of manuscript for the printer, the sending of proof to the authors, and the final correction of the galleys and the make-up of the issues. The Editors also wish to thank Mr. FRANCIS C. HARWOOD, of the Waverly Press, for his helpful suggestions in connection with the printing of the JOURNAL.

ALAN STONE.
FRANK C. KRACEK.
FREDERICK J. HERMANN.

REPORT OF CUSTODIAN AND SUBSCRIPTION MANAGER OF PUBLICATIONS

Subscriptions

Nonmember subscriptions in the United States and possessions	143
Nonmember subscriptions in foreign countries	80
Total	223

This is a gain of 20 subscriptions over last year's number, and represents the highest total in the 10 years since this office was created. It is hoped that this growth will continue in the coming year.

Inventory of stock as of December 31, 1949

Reserve sets of the Journal

Complete sets, vols 1–39	4
Volumes 11–39	6
" 16–39	9
" 21–39	5
Total sets more or less complete	24

Back numbers of the Journal

Numbers in complete sets (4)	2,604
Numbers held in reserve for complete sets	8,023
Numbers held for sale separately	—*
Total back numbers on hand	—*

Proceedings

Complete sets, volumes 1–13 (1899–1911) 48 sets

(The copies of the separate articles in the Proceedings that are on hand have not been counted.)

Monograph no. 1

Original issue	1,010
Copies sold or otherwise distributed	94
Number of copies on hand	916

* A count of these separate numbers has not been made recently, pending a rearrangement of the back stock and a subsequent recount and audit.

Sales

During the year two complete sets of the JOURNAL were sold, one to the Communicable Disease Center of the U. S. Public Health Service in Atlanta, Ga., and the other to the Swiss Federal Institute of Technology in Zurich, Switzerland. One set of the Proceedings was sold to the latter institution as well. In addition, 273 numbers of the JOURNAL were sold, either separately or as volumes. This is a considerable increase in sales over last year, when no sets were sold, and only 195 separate numbers were sold.

Eight numbers of the Proceedings and three copies of the 1947–48 Directory were sold.

On January 22, the first number of the Monograph Series of the Academy was published, a work by Dr. Herbert Friedmann of the U. S. National Museum, entitled *The parasitic cuckoos of Africa*. The issue of this book numbered 1,010 copies. Of these, 10 were given to the author as free copies, and 15 were sent to scientific journals for review. During the year 17 copies were sold to the author (at a 20-percent discount), 30 to dealers (at a 10-percent discount), and 20 were sold directly at the full price of $4.50. The number of copies sold was therefore 67. Attempts will be made this coming year to circularize prospective buyers and interested parties to increase the sales of this book.

During the year the Academy received from one of its members, Dr. N. ERNEST DORSEY, an almost complete set of the JOURNAL. This generous gift enabled us to make up a reserve set of the JOURNAL to replace one of the two sold. To Dr. Dorsey, and to the other members who from time to time have donated copies to this office, the Academy is deeply indebted. We are still anxious to obtain early volumes of the JOURNAL in order to make up more complete sets, for which we feel there will be a continuing demand.

The income from all sales during the past year was $987.61. This is the highest that this figure has ever reached.

Expenditures

Supplies	$ 8.26
Postage expended in connection with JOURNAL	11.62
Postage expended in connection with Monograph	10.31
Telephone call	.50
Storage charges for stock held at Baltimore	11.—
Total	$41.69
Refund, sales—1949	.20
Net expenses	$41.49

Storage

The charge for storage listed above will be a more or less constant annual expenditure, as arrangements have been made to remove at the end of each year the remaining stock of numbers of the last volume from Baltimore to the storage room kindly furnished by the officials of the Smithsonian Institution to the Academy for this purpose. In the early part of this year the stock formerly held in storage by the George Banta Publishing Co., in Menasha, Wis., was shipped here. As mentioned earlier in this report, the rearrangement of our storage facilities is in process.

HARALD A. REHDER.

REPORT OF THE ARCHIVIST

The archives have been kept in my office in the Soils Building at the Plant Industry Station in Beltsville. A portion of them are in a 4-drawer steel vertical file and in a 3-drawer wooden vertical file section, which belong to the Academy. In addition, a steel safe and two bookcases, which are the property of the laboratory, are occupied.

During the year the archives have not been disturbed except in the few cases when members have requested certain information, which I was happy to give. It seems to me that the archives should be consulted oftener than they are. Perhaps one reason for the lack of interest in them is the fact that the books containing the minutes of the meetings of the Board of Managers are kept in the Secretary's Office. That is more convenient since he has to refer to them often.

NATHAN R. SMITH.

The General Chairman of the Committee on Awards for Scientific Achievement, W. A. DAYTON, announced the recipients of the Academy Awards for 1949 as follows:

Biological Sciences: Dr. EDWARD G. HAMPP, National Institutes of Health, in recognition of his original and fundamental contributions to the knowledge of diseases of the oral cavity, particularly because of his being the first to isolate in pure culture *Borrelia vincentii*, thus making possible new approaches to the study of spirochetes.

Engineering Sciences: Dr. RICHARD K. COOK, National Bureau of Standards, in recognition of his distinguished service in acoustics and his method of absolute calibration of microphones.

Physical Sciences: Dr. JOHN A. HIPPLE, National Bureau of Standards, in recognition of his distinguished service in advances in mass spectrometry and in the precise measurement of atomic constants.

REPORT OF THE COMMITTEE ON MEMBERSHIP

During the Academy year the Committee on Membership has held 8 meetings and has processed 59 nominations for membership. Of these 59 nominations, 23 represent the physical sciences, 17 the engineering sciences, and 23 the biological. The scientific background and the achievements of each nominee were abstracted and presented to the Board of Managers at its regular meetings.

The Chairman of the Committee wishes to place on record his thanks and appreciation to all members of the Committee for their kind cooperation in carrying on the work, and to the President and members of the Board for many helpful suggestions.

H. E. McComb, *Chairman.*

REPORT OF COMMITTEE ON ENCOURAGEMENT OF SCIENCE TALENT

The Committee arranged for the participation of the Academy, as sponsor, in the Eighth Science Talent Search of the Westinghouse Educational Foundation. This first talent search in the District of Columbia resulted in the selection by the Committee of seven local participants in the national search to receive an award of a certificate of merit from the Academy. The awards were presented by the Academy at its Honors Meeting in March 1949. The Academy is sponsoring the local talent search again this year, and the Committee will recommend its selections to the Board of Managers in February.

The Academy, through the Committee, again sponsored the Annual Science Fair for local high-school students, held April 1–9, 1949, in cooperation with the science departments of the Public Schools of the District of Columbia. Over 600 exhibits were judged by members of the Academy to receive locally donated awards. The Fourth Annual Science Fair is now being arranged.

The problems of formation of a Junior Academy of Sciences are being studied by the Committee, and recommendations will be made to the Board of Managers in the near future.

The expense of the Committee consisted of $100, representing the Academy's contribution to support of the Third Annual Science Fair.

Martin A. Mason, *Chairman.*

REPORT OF COMMITTEE ON THE INDEX TO THE JOURNAL

In pursuance of the Committee's report of last year and in accordance with the contract, which was signed January 5, 1949, Miss Mary A. Bradley has been at work preparing an author-subject index for the first 40 volumes of the Journal. The work is going forward independently, with Miss Bradley making periodic consultations with Mr. Oehser; as the index of each volume is completed, the copy in the form of index cards is brought to Mr. Oehser's office in the Smithsonian Institution Building. By the end of the year 1949, Miss Bradley had delivered the index copy for volumes 1 through 15, thereby fulfilling the specifications and the time schedule of work as attached to the contract.

Miss Bradley's bill in the amount of $500, which was due on the completion of the above stint, has been approved for payment by the Chairman of the Committee and has been forwarded to the Treasurer for payment.

Since there were no further matters of general policy for the Committee to determine, no meetings were called by the chairman.

Your Committee wishes to advise, however, that the work of preparing the index will be completed by the end of 1950. It is not too early, therefore, to make definite plans and devise some means for the early publication of the index while Miss Bradley is still available, under terms of the contract, to see the index through the press.

W. N. Fenton, *Chairman.*

After acceptance of the report of the Committee of Tellers by the members, the President declared the following individuals elected to the given offices:

Nathan R. Smith, *President-Elect*
Frank M. Setzler, *Secretary*
Howard S. Rappleye, *Treasurer*
Howard P. Barss and A. T. McPherson, *Board of Managers to January 1953.*

The following members of the Academy were nominated by the Affiliated Societies for Vice-Presidents of the Academy:

Philosophical Society of Washington—Frank C. Kracek
Anthropological Society of Washington—Waldo R. Wedel
Biological Society of Washington—
Chemical Society of Washington—James I. Hoffman
Entomological Society of Washington—C. F. W. Muesebeck
National Geographic Society—Alexander Wetmore
Geological Society of Washington—James Steele Williams
Medical Society of the District of Columbia—Frederick O. Coe
Columbia Historical Society — Gilbert Grosvenor
Botanical Society of Washingtom—Freeman A. Weiss
Washington Section, Society of American Foresters—William A. Dayton
Washington Society of Engineers—Clifford A. Betts
Washington Section, American Institute of Electrical Engineers — F. M. Defandorf

Washington Section, American Society of Mechanical Engineers—Richard S. Dill
Helminthological Society of Washington—Emmett W. Price
Washington Branch, Society of American Bacteriologists—Margaret Pittman
Washington Post, Society of American Military Engineers—Henry W. Hemple
Washington Section, Institute of Radio Engineers—Herbert G. Dorsey
District of Columbia Section, American Society of Civil Engineers—Owen B. French

The members instructed the Secretary to cast a unanimous ballot for these nominees.

The retiring President, F. H. H. Roberts, Jr., expressed thanks to the members, officers, and Board of Managers for their cooperation. He then introduced the new President, Francis B. Silsbee, who had served as President-Elect during 1949. Dr. Silsbee after a few interesting remarks adjourned the meeting at 9:45 p.m.

Frank M. Setzler, *Secretary.*

437TH MEETING OF BOARD OF MANAGERS

The 437th meeting of the Board of Managers, held in the Cosmos Club on April 17, 1950, was called to order by the President, F. B. Silsbee, at 8:07 p.m. Also present were: N. R. Smith, H. S. Rappleye, J. A. Stevenson, F. C. Kracek, F. M. Defandorf, H. P. Barss, A. T. McPherson, J. I. Hoffman, J. S. Williams, F. A. Weiss, W. A. Dayton, C. A. Betts, R. S. Dill, Margaret Pittman, O. B. French, F. M. Setzler, and, by invitation, R. G. Bates.

The Chairman of the Committee on Meetings, F. M. Defandorf, reported that the May 18 meeting of the Academy would be a joint meeting with the Anthropological Society of Washington, at which time F. M. Setzler would deliver his lecture on *Aboriginal Australia.*

The Chairman of the Committee on Membership, R. G. Bates, submitted the names of 12 nominees for resident and 3 for nonresident membership. Seventeen individuals previously nominated were elected to resident membership.

The Committee on the Encouragement of Science Talent reported that the annual Science Fair sponsored by the Academy would be held on May 15–19, 1950.

The Archivist, J. A. Stevenson, indicated that he and N. R. Smith are continuing the work of organizing the Academy's archival records.

The meeting was adjourned at 8:45 p.m.

F. M. Setzler, *Secretary.*

Obituaries

Hobart Cutler Dickinson was retired in 1945 at the legal age limit of 70, after having served 40 years as a physicist at the National Bureau of Standards. This emeritus rating gave him the opportunity to put his youthful energy into a new research of his own choosing. This he enjoyed for four years until cancer ended his career on November 27, 1949, only a few weeks after he had started the final plans for the sequel to his earlier book in the field of economics.

Dickinson was born in Bangor, Maine, on October 11, 1875. Although he descended from a line of Congregational ministers, he said from his early boyhood that he wanted to be an inventor. In 1880 his parents left New England to live in the Central States; but in 1890 his father returned to Massachusetts and the boy, then 15, made the trip from Nebraska in a freight car with the family belongings, including two horses that had to be fed and watered. During the trip the car was in a wreck that demolished the animal stalls, and the young lad had to use his inventive ability to get at the tools and repair the damage.

In 1900 he was graduated from Williams College and continued there under Dr. C. W. Waidner to get his M.A. in 1902. He spent the next year at Clark University under Prof. A. G. Webster and returned there in 1910 to get his Ph.D. In 1903 he followed Dr. Waidner to the National Bureau of Standards and in the next ten years was the coauthor of several fundamental papers on thermometry. His doctor's thesis was on combustion calorimetry, and his design of calorimeter, with some refinements, is still yielding the most accurate results attainable today. From 1912 to 1917 he was in charge of work at the Bureau of Standards on the constants of refrigeration in a program sponsored by the American Society of Refrigeration Engineers. He contributed to this program as coauthor of papers on the calorimetry of ice and on the thermal conductivity of insulating materials.

At the onset of World War I, the bureau director, Dr. Stratton, asked him to assist in the development of aircraft engines, and he participated in the design of the Liberty Engine, which was one of the engineering triumphs of that time. Dickinson organized the aeronautical power-plant section of the heat division in 1917 and was largely responsible for the design and operation of the first altitude chamber in which full-sized aircraft engines were tested under conditions simulating altitudes up to 35,000 feet. After the war the activities of the section were expanded to embrace automobiles and their behavior on the road, including the performance of headlights and brakes. One of his many articles in this period was entitled "What is Safe Speed?" wherein he established the "clear course rule" which has become accepted in several States as the basic element of traffic regulations. He was instrumental in getting the automotive and petroleum industries to cooperate in research on the mutual adaptation of engines and fuels. From 1921 to 1923 he organized and directed the research department of the Society of Automotive Engineers at the headquarters in New York City, and in 1933 he was president of that society.

In 1923, after the death of Dr. Waidner, he returned to the Bureau of Standards as chief of the Division of Heat and Power and continued in that capacity until his retirement. During this period he devoted special attention to the power part of the division and organized it into separate sections on automotive research, aircraft engines, and lubrication.

About 1930 he began a study of the factors involved in economic depressions. He applied the physicist's mathematical analysis to economics and constructed a mechanical analogy to illustrate it. This study led to the publication, in 1937, of his book *The mechanics of prosperity.*

Dickinson was an ardent hiker and preferred to spend his vacations in the mountains. In his later years he served the Potomac Appalachian Trail Club in its program of shelter building. On his first trip to the Canadian Rockies with the Alpine Club of Canada he took only a small spare blanket and water-repellent sheet when he should have taken all his own bedding. Confronted with bleak prospects he remembered his measurements on insulating materials and with his usual resourcefulness gathered balsam boughs in considerable quantity to put between his blanket and his sheet. The result astonished him, and he soon learned that a relatively small thickness of balsam furnished sufficient insulation to keep him pleasantly warm even on freezing nights.

He was married in 1903 to Elizabeth S. Wells, who died in 1921. He was married again in Scarborough, England, to Mabel V. Kitson in 1923. Their daughter Anne and her husband, Hugh N. Ross, have carried on the scientific tradition of the family. Both graduated in physics at the University of Maryland. Ross is now continuing the research on the thermal conductivity of high-temperature insulators that Dickinson chose after his retirement.

H. F. STIMSON.

GEORGE SAMUEL RICE died at the Washington Sanitarium in Takoma Park, Md., on Janu- 4, 1950. He was a pioneer in applying scientific knowledge to increase safety and improve efficiency in mining. Born in Claremont, N.H., on September 6, 1886, he received an E.M. degree from Columbia University in 1887, and for two decades served the mining industry as a geologist, mining engineer, or superintendent of production, involving coal, lead, zinc, phosphate, and potash.

In 1908 he was invited to join the Technological Branch of the U. S. Geological Survey to investigate the causes of coal-mine explosions and seek remedies to eliminate them.With the establishment of the Bureau of Mines in 1910, the work was transferred to that agency, and Dr. Rice became the chief mining engineer, with headquarters first at Pittsburgh and later in Washington. He served in that capacity until his retirement in 1937.

Dr. Rice was a prime mover in the bureau's efforts to prevent coal-mine explosions. Under his direction, a steel gallery was constructed at Pittsburgh, Pa., and the Experimental Mine, at Bruceton, Pa., was developed to test the explosibility of coal dust. Many miners owe their lives to his success in reducing the number of explosions in coal mines and in inaugurating other safety practices.

As early as 1891, Dr. Rice observed that coal-dust explosions in a coal mine in Iowa died out in areas where the dust was high in ash. His observations were presented before the Illinois Coal Mining Institute and published in the 1893 Transactions.

In 1911, he was made a member of the Canadian Government's Commission to determine landslide hazards from mining operations, an investigation inspired by the Turtle Mountain rock slide. A year later he organized the first international conference of mine-safety research investigators, which met in Pittsburgh. He was a pioneer in the introduction in the United States of permissible mine explosives, mine rescue apparatus, and the use of rock-dust in coal mines to prevent coal-dust explosions.

During World War I, Dr. Rice suggested that the Bureau of Mines' engineers and chemists, experienced in dealing with explosives and poisonous gases in mines, would be of great assistance in developing masks to protect our troops against war gases. The project was instituted by the bureau and later transferred to the War Department. During the Armistice, he reported on war damage to French and Belgian mining and metallurgical plants.

From 1919 to 1922, when the Holland Vehicular Tunnel between New York and New Jersey was being constructed, he participated in ventilation tests and studies.

He visited Europe in 1923 as a representative to the International Mining Congress in London and, while abroad, studied progress in the use of rock-dust to prevent coal-dust explosions, methods of mining oil shale in Scotland and oil sands in France and Germany, potash mining in France and Germany, and hydraulic stowing to prevent or minimize surface subsidence.

Dr. Rice arranged for cooperation in mine-safety research between the bureau and the British Mines Department, serving as liaison officer until his retirement. During 1928 he investigated disastrous outbursts of gas in certain coal mines in Belgium, southern France, and lower Silesia. In 1935 he was the United States representative to the Seventh International Congress on Mining and Applied Geology in Paris.

He received international recognition for his outstanding services. In 1923, the British Institution of Mining Engineers, of which he was made an honorary member, awarded him a medal for "eminence in all matters relating to the safe working of coal mines— with special reference to the practical application of scientific knowledge." In 1931 he was awarded a medal by his alma mater, Columbia University. In 1936 he was awarded a degree of Doctor of Science by Lafayette College. In 1937 he was made an honorary member of the Canadian Mining and Metallurgical Institute. He was also an honorary member of La Societe de l'Industrie Minerale, France. In 1946 he was awarded a medal by the Joseph A. Holmes Safety Association.

Among the other organizations with which Dr. Rice was affiliated were the Geological Society of Washington (since 1923), the American Institute of Mining and Metallurgical Engineers, the Dust Explosion Hazard and Mine Correlating Committees of the American Standards Association, the Mining Society of America, the American Association for the Advancement of Science, the Coal Mining Institute of America, the Washington Society of Engineers, the Washington Academy of Sciences, and the Cosmos Club.

At various times he assisted in the revision of mine-safety regulations in various states, and he nitiated a conference of representatives from public-land states for the purpose of drafting regulations to apply to mining operations on public lands under lease from the Government.

His passing is deeply regretted by his former associates and friends and by those who knew him through his publications. His work and publications are of enduring value to the mining industry. Surviving are his widow, Mrs. Sara Marie Rice; a daughter, Mrs. Katherine Mollison, of Wellesley Hills, Mass.; a son, J. Brewster Rice, of Short Hills, N. J.; and a brother and four grandchildren.

H. I. Smith.*

Clarence Arthur Reed, a member of the Washington Academy of Sciences, passed away on January 14, 1950—a few days before his 70th birthday—in a Lakeland, Fla., hospital after a brief illness. He had suffered from a heart condition for several years.

Mr. Reed was born on January 23, 1880, in Howell, the county seat of Livingston County, Mich. He graduated from Michigan State College in 1905 with the degree of B.S. and received the degree of master of horticulture from the same institution in 1913. He married Miss Katherine McNaughton in 1910, who, with a daughter, Mrs. Harris Richardson, of Washington, survives him. His first employment was with a Chicago landscaping firm. In 1906 and 1907 he was assistant horticulturist at the Maryland and West Virginia Agricultural Experiment Stations, respectively. He was the first man in the U. S. Department of Agriculture to be assigned exclusively to nut investigations and, from 1907 to his retirement in 1947, was associate pomologist and specialist in nut investigations in the Bureau of Plant Industry (now Plant Industry, Soils, and Agricultural Engineering) of that Department. Mr. Reed's special interests were in the pecan, filberts, walnuts, and chestnuts. Two of his filbert novelties (nos. 1667 and 2336) are now under test. He played a leading part in establishing the experimental stations for nut production, breeding, and disease-prevention at Shreveport, La., and Albany, Ga. His work also led to Congressional appropriations establishing pecan experiment stations in several parts of the country. He spent four months in China in 1922 investigating the local Persian walnut situation, removing fears of American growers of Chinese competition in that field.

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* Communicated to the Geological Society of Washington at its meeting held on March 8, 1950.

At the time of his death Mr. Reed was engaged in preparing a book on nut culture to be published by Chronica Botanica. It is hoped that some competent person can take up his large manuscript and carry it to completion. Mr. Reed was a prolific writer, especially in the nut journals, and the 50-odd titles listed in the Department of Agriculture Library card catalogues perhaps represent only a third of his published papers. Among his best-known works are the Department of Agriculture bulletins on the pecan and on nut-tree propagation. He was the author of the nut names lists in *Standardized plant names* and prepared articles on nut culture for the Encyclopedia Brittanica.

Mr. Reed was a member of the Botanical Society of Washington, was a past president of the Northern Nut Growers Association, was elected in 1929 as the first (and only) honorary member of the National Pecan Growers Association, and, from 1919 until his resignation in 1938 was a member of the Cosmos Club. He was the recipient of the Wilder Medal of the American Pomological Society for his work with filberts.

Mr. Reed resided at 7309 Piney Branch Road, Takoma Park, and was active in religious, civic, and philanthropic enterprises. He was a counselor for the Boy Scouts of America, an elder in the Takoma Park Presbyterian Church, and has been Sunday School superintendent and president of its Brotherhood Club. It is well known that the black walnut stands of the country were depleted during World War I, due particularly to heavy utilization for gunstocks and airplane propellers, and Mr. Reed took the initiative in having boy scouts collect, distribute, and plant black walnuts. He was much interested in the Takoma Park Improvement Association and was instrumental in having a scion of the famous Washington Elm of Cambridge, Mass., planted in the local park. The writer recalls the deep hurt Mr. Reed felt at the wholly unjustified and inaccurate questioning of the origin of this scion by a distinguished American scientist. Mr. Reed's disposition and nature were marked by unaffected kindness, simplicity, integrity, loyalty, and sympathy; his friends were legion.

William A. Dayton.

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Vol. 40 July 15, 1950 No. 7

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

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Manuscripts may be sent to any member of the Board of Editors. It is urgently requested that contributors consult the latest numbers of the Journal and conform their manuscripts to the usage found there as regards arrangement of title, subheads, synonymies, footnotes, tables, bibliography, legends for illustrations, and other matter. Manuscripts should be typewritten, double-spaced, on good paper. Footnotes should be numbered serially in pencil and submitted on a separate sheet. The editors do not assume responsibility for the ideas expressed by the author, nor can they undertake to correct other than obvious minor errors.

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Proof.—In order to facilitate prompt publication one proof will generally be sent to authors in or near Washington. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

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* Limited number of complete sets of the Journal (vol. 1 to vol. 39, incl.) available for sale to libraries at $333.50.

Monograph No. 1, "The Parasitic Cuckoos of Africa," by Herbert Friedmann. .$4.50

Proceedings, vols. 1–13 (1899–1911) complete	$25.00
Single volumes, unbound	2.00
Single numbers	.25

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JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOLUME 40 July 15, 1950 No. 7

ARCHEOLOGY.—*Four Hopewellian tumuli in western New York.*[1] EDMUND S. CARPENTER, University of Toronto. (Communicated by W. N. Fenton.)

In 1941 the writer explored two burial mounds in western New York for the Pennsylvania Historical and Museum Commission and eight years later opened two neighboring tumuli for the Indiana Historical Society.[2] All belong to the Hopewellian complex as seen in this region.

In no other area in northeastern North America were so many evidences of this prehistoric complex originally manifest. Yet the disheartening fact remains that of the literally hundreds of small conical burial mounds that once stood in this region, only a handful escaped early destruction. A few tantalizingly brief reports on the work of Reynolds, Larkin, Love, and Benedict exist in manuscript form, and there are occasional records of accidental discoveries and of amateur excavations. But these offer only glimpses here and there. Indeed, the fragmentary data presented in this article constitute a large portion of the evidence now above ground.

This becomes particularly unfortunate when it is realized that a knowledge of this prehistoric manifestation is of the first importance in current archeological thought in the Northeast. Perhaps the major problem in this area is that of explaining the intrusive linguistic and cultural position of the Iroquois. Contemporary workers tend to discount the older concept of a late migration of Iroquoian people with a fully formed, basically southern culture into the Northeast, in favor of successive cultural influences from the south, particularly the Ohio Valley, and the development *in situ* of Iroquoian culture.

Archeological evidence indicates that the largest, though probably not the first, southern movement into this region was made by people with a Hopewellian culture who migrated north along the west side of the Allegheny Mountains and from there entered the Northeast. It is significant that this is the only prehistoric complex known to have introduced southern traits into northern Iroquoia and to have also penetrated the homeland of the historic Cherokee, another branch of this linguistic family. For along the headwaters of the James River and in northwestern North Carolina there once stood a large number of tumuli, known only through the unpublished work of Fowke and Valentine, that differed in no way from the Northeastern Hopewellian tumuli. This is the only early culture known to have been shared by both Iroquois regions. As such it remains a favorite candidate for the distinction of having introduced the Iroquois language and sib organization into the Northeast, although no necessary coincidence between linguistic and material culture boundaries can be proved. It is believed that the foundations for basic Iroquois culture were introduced into their historic homes at this time and in this manner, bringing a transition from a food-gathering to a food-producing economy and firmly drawing the lines between Algonkian and Iroquoian cultures. Varied southern traits and complexes reached these northern farmers from this period on down into historic times.

Such an interpretation appears to be in keeping with both linguistic and ethnological evidence. On linguistic grounds, the separation of northern and southern Iroquois groups must have been quite early and probably originated in the Ohio drainage area.

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[1] Received April 26, 1950.

[2] This report is published by permission of the secretaries of both institutions. All artifacts recovered were deposited in the Rochester Museum of Arts and Sciences, Rochester, N. Y.

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And archeological suggestions of the synthesis of a maize industry with a northern hunting culture to produce in time the distinctive Iroquoian culture, merely confirms what we have independent reason to believe on the basis of ethnological data.

Thus it can be seen that the remnants of these once numerous tumuli are currently of major interest. Standing midway between the famed Ohio Hopewell center and the heart of Iroquoia, they offer evidence of the nature of the Hopewellian traditions that radiated out from southern Ohio and reached the northern Iroquois.

KILLBUCK MOUND, CATTARAUGUS COUNTY, N. Y.

Within the town of Killbuck, N. Y., there is a small plot of land that was not included in the original lease of the town site from the Iroquois of the Allegany Reservation. The Baltimore & Ohio Railroad cuts across its northern boundary, while the property of Lymon Blackman encloses the remaining sides. For years this tiny woodlot has been regarded by the Seneca as an Indian burial ground and indeed there is good evidence of interments here within the past century. It is important to note, however, that these historic graves were simple burials that lay some 30 feet west of a much-disturbed prehistoric mound on the site. Perhaps the latter had attracted more recent Indians who recognized it as a native cemetery. Our excavations here in 1949 were limited solely to the prehistoric mound.

Of earlier discoveries here there is no record. Previous excavators had removed a small portion of the central area and left holes along the northern side. But owing to a rather interesting feature, most of the burials were undisturbed. The mound, which overlooked the northern flood plain of the Allegany, had been built on the side of a pronounced slope or terrace bank. Though the mound was only 35 feet in diameter, the northern floor, which was the original ground surface, was 3 feet higher than the southern floor. On this sloping base a conical muond of light, sandy loam had been constructed. Erosion, and probably plowing, had so reduced the structure that it blended into the terrace contours, probably misleading earlier excavators, who confined their explorations to the northern portions.

The entire outline of the tumulus could be traced with ease, for the duff line of the old living surface clearly separated the mound structure from the original ground level. Above this stratum the mound attained, in 1949, a maximum center height of 2 feet 9 inches. Several burials, specifically numbers 2, 3, and 6, had apparently been made by scooping out shallow graves on the ground surface, for they lay a foot or more below this duff line. At one other point, an area roughly 2 feet in diameter near the mound center, this stratum was broken. Here, resting on the original ground surface, was a deposit, about the size of a bushel basket, of ash, charcoal, and hard, compact earth that had been subjected to intense heat. Covering this was a stone slab, 21 by 16 inches that had apparently been removed by earlier explorers and then replaced, for the earth immediately below the slab was disturbed. Nine burials were recorded:

Burial 1: Disturbed adult burial of which only long bone fragments remained.

Burial 2: Disturbed adult burial of which only long bone fragments remained.

Burial 3: Extended adult skeleton, probably the central burial; condition very poor; head to southwest, face to east; on each side of the cranium lay basin-shaped copper pieces, probably ear spools (Fig. 1, *l*); on the chest lay a crude pentagonal (?) slate gorget (Fig. 1, *n*) and two large chert flakes.

Burial 4: Calva of an infant.

Burial 5: Adult burial of which only the long bones and teeth remained; near the teeth lay seven spheroidal native copper beads (Fig. 1, *k*) and immediately to the east a deposit of limonite covering an unperforated, gorgetlike specimen (Fig. 1, *m*), a side-notched projectile point of chalcedony (Fig. 1, *g*), chert chips, possibly used as strike-a-lights, and an ovate scraper (Fig. 1, *a*). Vertebrae that lay just below the duff line appeared nearby.

Burial 6: Disturbed adult burial of which only the long bones remained.

Burial 7: Closely flexed skeleton of a child; head to the north but twisted about the face southeast; condition fair. Behind the cranium appeared several calcined bone fragments and two worked slabs of slate, possibly the raw material for gorgets.

Burial 8: Bundle burial of a child of about 10 years; condition very poor; bones disarticulate except for the ribs which were in general alignment.

Burial 9: Bundle burial of a child of about 8 years; condition very poor; lying directly beneath burial 8.

From the mound fill came a side-notched projectile point of Onondaga chert (Fig. 1, *h*) and a triangular projectile point of light grad chert (Fig. 1, *i*).

VANDALIA MOUNDS, CATTARAUGUS COUNTY, N. Y.

Two of the tumuli explored by the 1941 expedition stood on the Allegany Reservation, southwest of Vandalia, N. Y.; more specifically on the southern bank of an abandoned river channel of the Allegheny that now follows a more northerly course. Route 17 passes a few feet south of the first mound, and to the east a tiny confluent empties into the stagnant river bed.

Mound 1 had been repeatedly opened, one major excavation being made around 1920 by King Tanty Jimerson, a local Seneca showman and "trickster" of prodigious talent who dug directly into the mound center (Fig. 2). His

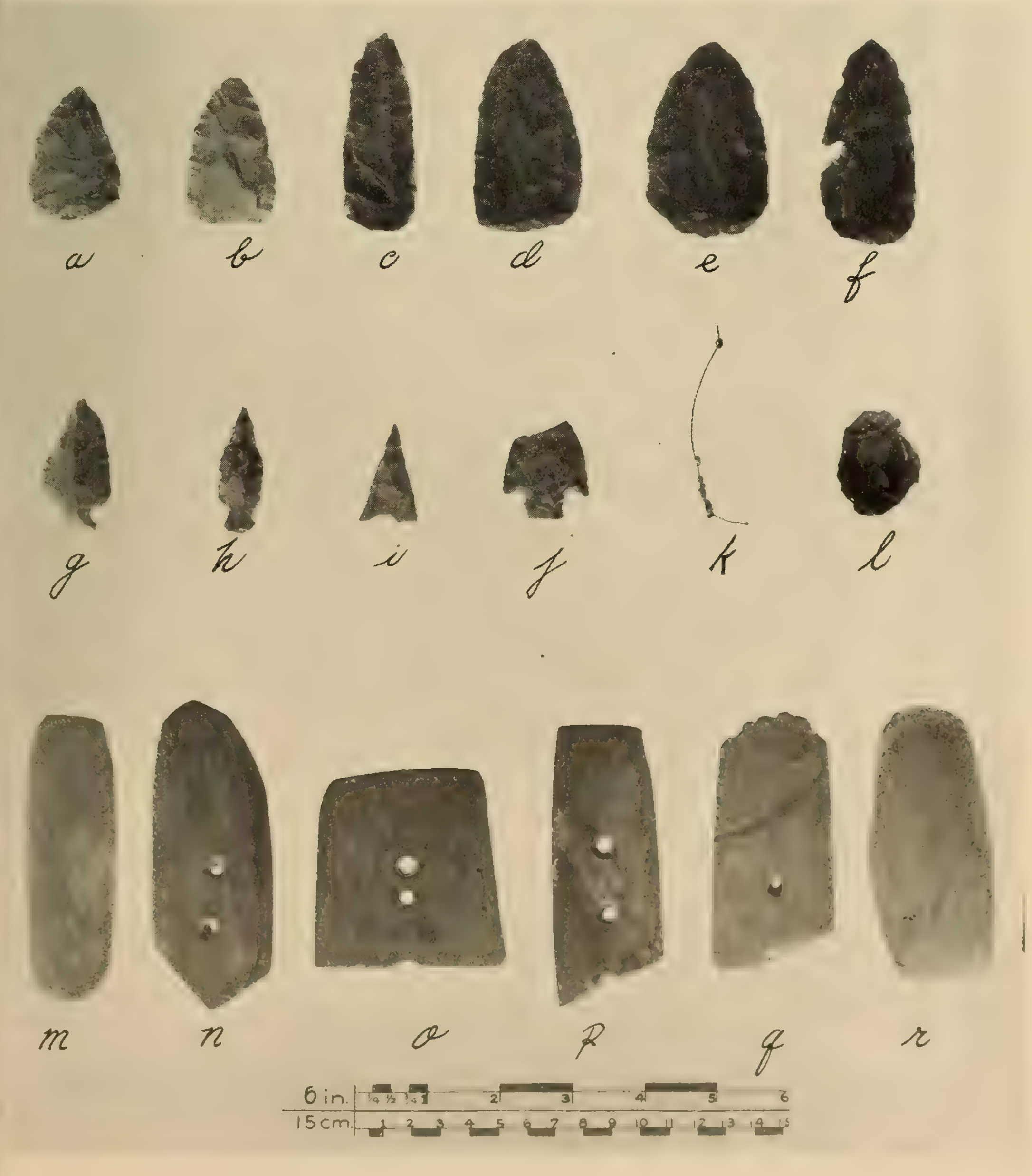

FIG. 1.—Artifacts from western New York mounds.

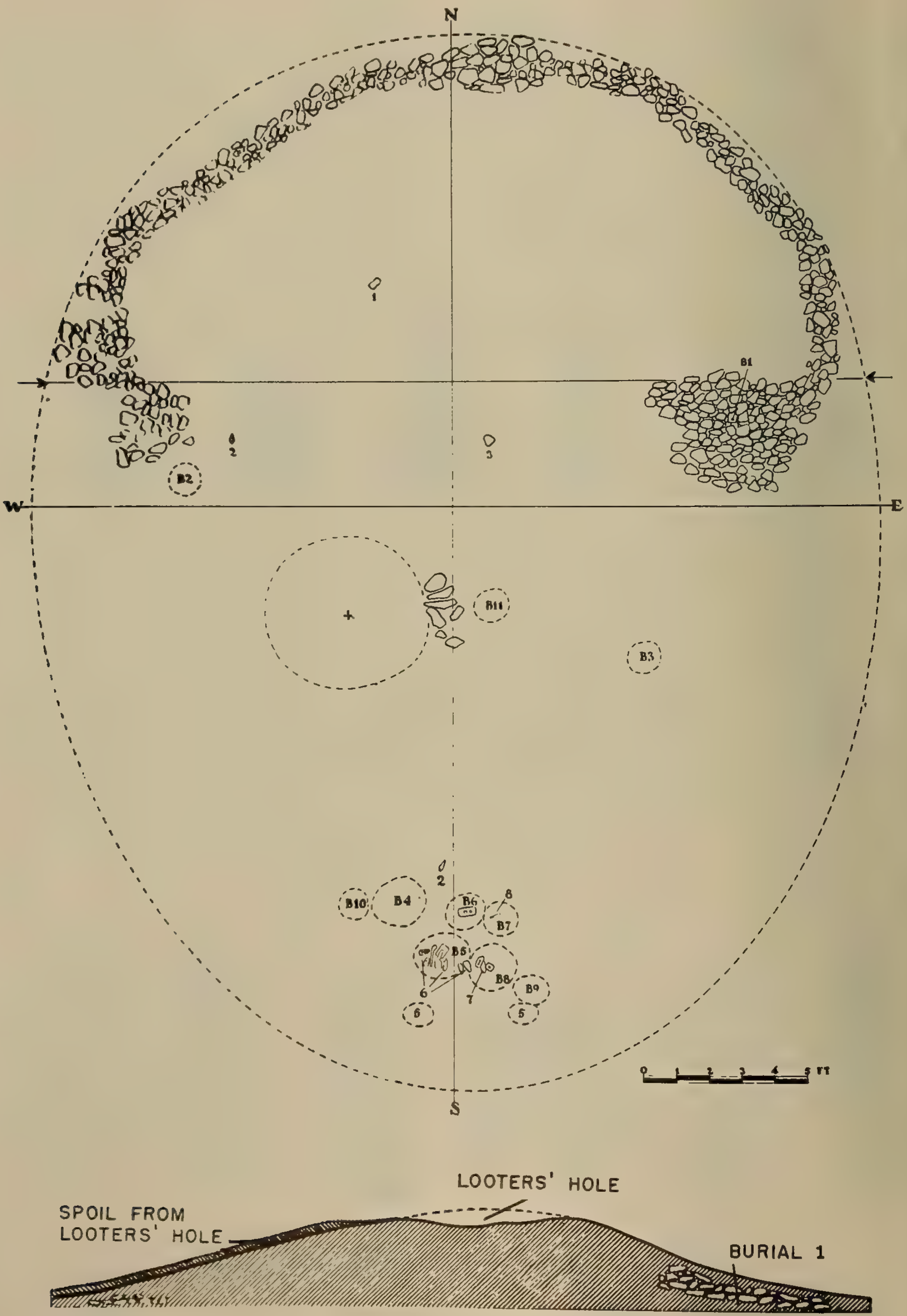

Fig. 2.—Vandalia mound, western New York.

discoveries remain unknown. However, human remains and cobblestone in the disturbed earth cast out from the mound center and remnants of a cist found *in situ* clearly showed that he had opened a centrally placed, cobblestone-covered grave of an uncremated adult male (burial 12). Immediately to the east of this cist, and also on floor level, lay burial 11, a disturbed cremation.

The original mound structure probably stood somewhat over 3 feet in the center and had a slightly oval or egg-shaped ground plan with a long axis of 32 feet. Sandy yellow soil, found adjacent to the mound, had been used throughout its construction and exhibited no lensed structure to the naked eye. No basal soil line was observed, thus suggesting floor preparation by complete removal of all humus accumulations.

On the ground level of the mound's northern periphery and just beneath the sod lay a pattern of unworked, waterworn cobblestones, averaging roughly 1 foot in width with a thickness of one and two stones (Fig. 2). In actual observation this stone design appeared far more symmetrical than accurate mapping disclosed. Slightly larger stones composed the center of the formation, and each end terminated in a circle of cobblestones. Directly beneath the northeastern circle appeared a few fragments of calcined bones (burial 1), red-ochre streaks, and small quantities of ash and charcoal. This latter, about three stones in thickness, was the only section of the design that followed the contour of the mound.

Burial 2, another small cremation, lay just outside the western cobblestone circle in a saucer-shaped depression sunk in the mound floor, 25 inches from the living surface. Charcoal streaks and stained earth appeared in a pocket immediately to the north-northeast. Nearby and about 8 inches under the mound floor lay the upper half of a large, crudely chipped, gray chalcedony projectile point.

Burial 3, a cremation covered with a small quantity of red ochre, was discovered on the southeastern side, 11 inches below the mound surface. Charcoal, ash, and chert chips were scattered sparingly throughout the grave.

In all, 12 burials were recorded: Numbers 4–10, all cremations, lay together at a uniform depth of 1½ feet below the original ground surface, in a subfloor pit. Here grave outlines were indistinct, for these latter skeletons were merely concentrations of calcined bones, each representing about half a quart, with fragments connecting all seven. A wealth of mortuary offerings accompanied them: three gorgets and a pentagonal pendant of Huronia slate, a native copper awl, powdered red hematite, a green stone celt, and five chert blades (Fig. 3).

Burial 4: Copper-stained cremation of an adult.

Burial 5: Cremation of an adult and child with first dentition. The adult tibiae were unburned, and on the left one rested a long slate gorget (Fig. 3, *o*), sandwiched between two flat stones, possibly for protection. Five cache blades of Onondaga chert accompanied the burial (Fig. 3, *b–e*).

Burial 6: Cremation of a young adult (?) accompanied by a gorget (Fig. 3, *r*) and a small ball of gray clay.

Burial 7: Child cremation with a double-pointed copper awl (Fig. 3, *j*).

Burial 8: Child cremation with gorget, celt, and pendant (Fig. 3, *p*, *g*, *l*).

Burial 9: Cremated remains of a young adult.

Burial 10: Copper-stained cremation with a small quantity of bright green clay.

In addition, from the mound fill came a hammerstone, net-sinker, anvilstone, and multiple pits on each side, plus a broken-stemmed projectile point or crude perforator of chert (Fig. 3, *a*, *f*, *n*, *i*).

MOUND 2

Immediately to the east of the first mound and on the adjacent property of Willie Gordon lay the remnants of a second low-lying tumulus. At the time of our excavations here in 1941, I examined this second mound and found most of the structure destroyed by erosion of the river-bank on which it stood. Calcined bone fragments and powdered red hematite were much in evidence. A few days earlier Mr. Gordon had discovered, within the mound, a cachelike deposit of the following artifacts: 12 cache blades of Onondaga chert (Fig. 1, *c–e*), 20 notched pebble net-sinkers, 2 steatite bowl fragments, a small celt (Fig. 1, *r*) and a slate gorget fragment (Fig. 1, *q*). The last specimen is polished at the break and serrated at the top.

An adjacent village site produced Laurentian-like artifacts and two fictile wares: a handful of Vinette I sherds and a larger number of similar sherds—the same color, temper, shape, paste, and hardness but lacking the interior cording.

Four other mounds were observed by the

writer in the immediate vicinity. All had been greatly disturbed by earlier explorers. In one of them, a larger oval mound roughly 30 by 60 feet, that lay in the general direction toward Chipmunk, the writer discovered a single cache blade of Onondaga chert (Fig. 1, *f*). From this same tumulus, King Tanty Jimerson is said to have recovered large copper awls.

POLAND CENTER MOUND, CHAUTAUQUA COUNTY, N. Y.

One of New York's largest tumuli stood on a high wooded hilltop on the Lindgren farm, overlooking the Conewango Valley and the now-abandoned town of Poland Center. Cheney (1859, pl. 3) described the structure in 1859, erroneously placing it in Conewango Township, Cattaraugus County:

> This work has some appearance of being constructed with the ditch and vallum outside of the mound, as in the Druid Barrows, but perhaps more accurately belongs to the class composed of several stages, as the Trocalli of the valley of Anahuac. The form of the tumulus is of intermediate character between an ellipse and the parallelogram; the interior mound, at its base, has a major axis of 65 feet, while the minor axis is 61 feet with an altitude above the first platform or embankment of 10 feet, or an entire elevation of some 13 feet. This embankment, with an entrance or gateway upon the east side 30 feet in width, has an entire circumference of 170 feet. As previously remarked, the work itself, as well as the eminence which it commands, and the ravine upon either side, are overshadowed by the dense forest. . . In making an excavation, eight skeletons, buried in a sitting position and at regular intervals of space, so as to form a circle within the mound, were disinterred. Some slight appearance yet existed to show that framework had enclosed the dead at the time of interment. These osteological remains were of very large size, but were so much decomposed that they mostly crumbled to dust. The relics of art here disclosed were also of a peculiar and interesting character—amulets, chisels and so forth, of elaborate workmanship, resembling the Mexican and Peruvian antiquities.

In 1905 Parker visited the site and noted that though considerably demolished by excavations, the mound still stood 9 or 10 feet high. He expressed some doubt, however, about the artificial nature of the surrounding ditch (Parker, 1922, p. 87).

Actually, the original height probably never exceeded 7½ feet, although to the eye it must have appeared far greater. At the time of our excavations there in 1949, the tumulus had a maximum height, excluding disturbed earth, of 6 feet 2 inches and a diameter of 52–45½ feet. A craterlike hole, presumably the excavation described by Cheney, marked the mound center, and other excavations, particularly along the sides, were much in evidence. No evidence of a surrounding ditch was observed, nor did test trenches indicate that such a feature had ever existed. Adjacent depressions, probably the source of mound earth, may have confused Cheney.

Our excavations here were limited to a 14-by-46-foot trench cut diagnonally through the mound center. On the periphery of the west side, just beneath the forest duff, we encountered a heavy concentration of stone slabs, apparently part of a central cist cast out by earlier explorers. Immediately beneath them lay still additional slabs, this time in undisturbed mound earth. They lay as an irregular pavement that followed the contour of the mound from the outer edge up the slope about 5 feet.

Without exception the mound earth consisted of the reddish-brown loam found adjacent to the tumulus. Beneath the structure was a hard, compact, 1½- to 2-foot gravel foundation, apparently of natural origin. This was broken by Cheney's excavation, which, incidentally, was far too small to have ever included eight separate burials. It was also broken at five other locations, all within 12 feet of the mound center. In three of these depressions, each but a few feet in diameter, lay two or three calcined bone fragments. A slate 3-holed gorget fragment, polished at the break (Fig. 1, *o*), accompanied one of these "burials." The remaining two held a few rotten, uncremated adult bones; the better of the two consisting only of a calva (head to the east) away from the mound center (missing face to the north), the tibiae and a 3-holed gorget fragment, again polished at the break and probably redrilled (Fig. 1, *p*). Both of these latter burials lay in graves cut into the gravel stratum that were of sufficient size and shape to enclose extended burials.

A corner-notched projectile point (Fig. 1, *j*) and the fragment of a blade or broad point appeared in the mound fill at ground level.

CONCLUSIONS

Sound opinion identifies these tumuli with the Northeastern Hopewellian complex, which had definite Ohio affinities. Known components occur in western New York, along the banks of the upper Allegheny and the Genesee, the Finger Lakes country, both northern and southern shores of Lake Ontario and the eastern shore of Lake Erie, near the headwaters of the James, and in northwestern North Carolina. Late sites are also known in north-central Pennsylvania. It is perhaps significant that this distribution largely coincides with the habitat of the historic Iroquois.

Over this broad geographical range one finds exactly those traits that occurred in the above tumuli: the small earth mound, occasionally with peripheral stone construc-

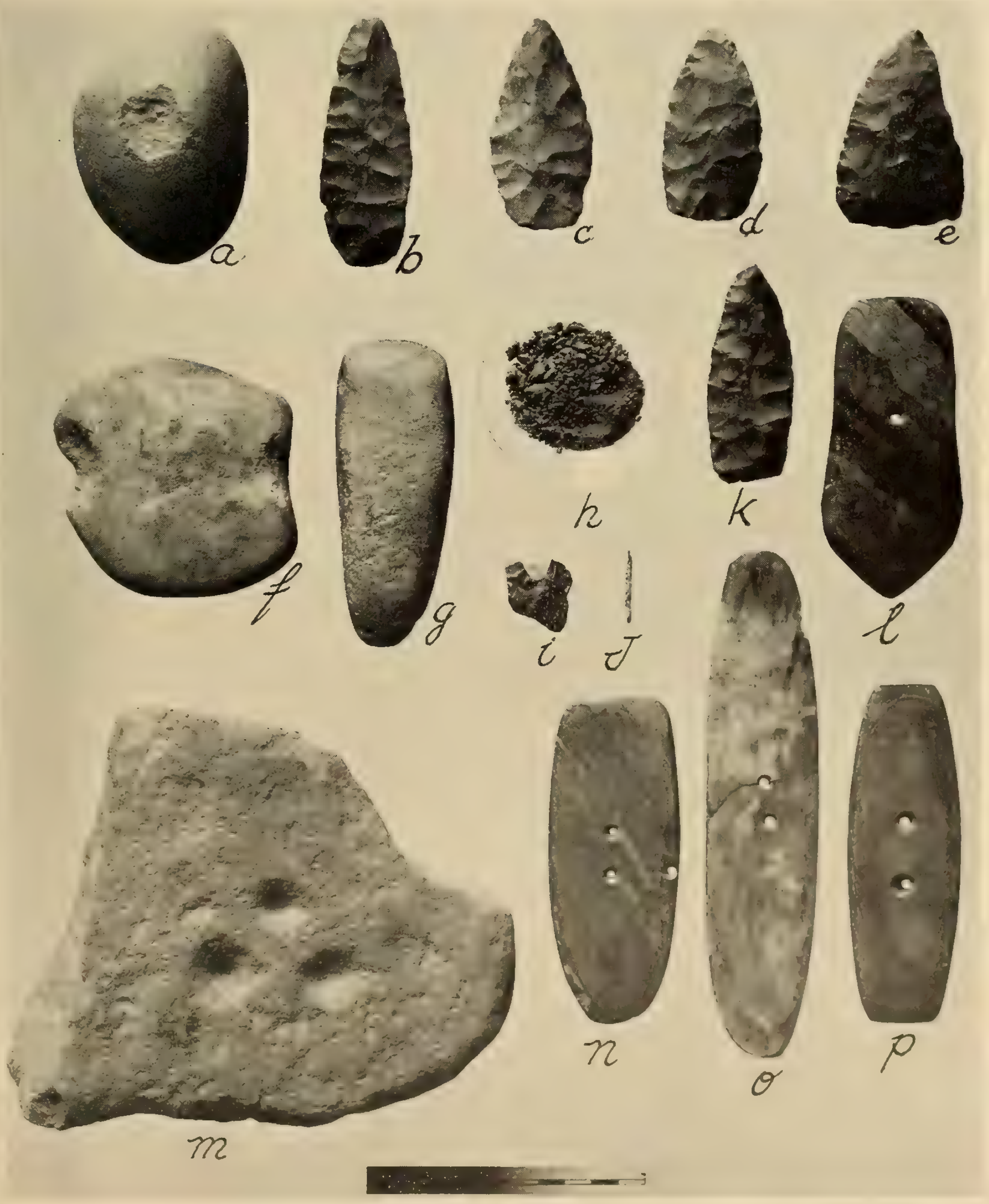

Fig. 3.—Artifacts from Vandalia mound, western New York.

tion; centrally placed, slab- or cobblestone-covered cist; cremated and flexed, bundle and extended burials; associated with the slate gorget, pentagonal pendant, copper awl, rude cache blade, copper bead, crude side-notched and triangular projectile points, strike-a-light kit, red and yellow ocher, copper ear-spool, stone celt, plus Vinette I and Point Peninsula Plain fictile types.

It is important to stress first that, without exception, all the Northeastern mounds on which data exist belong to this complex, and second, that these tumuli were originally quite numerous. Such findings tend to weaken the objections that a handful of Hopewellian emigrés could not have been the progenitors of such an extensive linguistic family as the Iroquois one. Association of the mounds with Laurentianlike villages sites and the non-Hopewellian nature of certain of the mound artifacts suggest that these early Woodland traditions were grafted on a late Archaic base, thereby producing a composite that contributed materially to the formation of the Point Peninsula Aspect. In short, the evidence presented here in no way contradicts current views on the relationship between the Northeastern Hopewellian complex and Iroquois culture but actually offers new supporting data.

The above seem to me to be conservative probabilities in the light of the very scanty traditions preserved to us in archeological data.

REFERENCES

Cheney, T. Apoleon. *Illustrations of the ancient monuments in western New York.* New York State Cabinet of Natural History **13**. Albany, 1859.

Parker, Arthur C. *The archaeological history of New York.* New York State Mus. Bull. 235. Albany, 1922.

BOTANY.—*A new* Puya *from Bolivia.*[1] Lyman B. Smith, Department of Botany, U. S. National Museum.

With few exceptions the species of *Puya* have extremely limited ranges and occur at high altitudes; so it is not surprising to find such a striking example as the one described below still unknown though within a relatively short distance of La Paz.

Puya fosteriana L.B. Smith, sp. nov. Fig. 1

Laminis foliorum supra glabris, subtus inter nervos minutissime albo-lepidotis; scapo brevissimo; inflorescentia densissime bipinnatim paniculata, cylindrica, brunneo-lanata; bracteis primariis reflexis, membranaceis, grosse serratis; floribus fasciculatis; bracteis florigeris acuminatis.

Flowering plant 1 meter high; leaves numerous, rosulate, 4–5 dm long, sheaths suborbicular, 9 cm in diameter, bearing a band of appressed cinereous scales beneath at apex, elsewhere glabrous, blades narrowly triangular, 5 cm broad at base, glabrous above, minutely pale-lepidote between the nerves beneath, laxly serrate with dark flat straight or hooked spines 9 mm long; scape very short, concealed by the leaves; inflorescence very densely bipinnate, thick-cylindric, rounded at apex, densely brown-lanate; primary bracts membranaceous, pale green, the suborbicular base equaling the sepals, the long narrowly triangular apex reflexed, coarsely serrate, branches much abbreviated, few-flowered; floral bracts broadly elliptic, long-caudate, exceeding the sepals, subentire, membranaceous; pedicels 1 cm long, rather slender; sepals linear-lanceolate, acute, 45 mm long, ecarinate, minutely and sparsely serrulate, submembranaceous; petals broadly elliptic, ultramarine (! Foster), dark purple at base (! Foster).

Type in the U. S. National Herbarium, nos. 1985828 and 1985829, collected in a cloud rock garden, La Rinconada, about 75 km east of La Paz, Department of La Paz, Bolivia, altitude about 4,400 meters, November 20, 1948, by Mulford B. Foster (no. 2573).

In its short scape and dense thick inflorescence *Puya fosteriana* resembles several other species of high altitudes. However, its membranaceous coarsely toothed primary bracts are quite distinctive, since this combination is found only in *P. vestita* André of Ecuador, a species with the floral bracts merely acute, broad sepals and sessile flowers. *P. brittoniana* Baker of Bolivia has thin bracts and narrow sepals like *P. fosteriana* but has a simple inflorescence, entire bracts, and much smaller sepals.

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[1] Published by permission of the Secretary of the Smithsonion Institution. Received May 10, 1950.

So far as known, *Puya fosteriana* grows at a higher altitude than any other member of the family, and so it is appropriately named for Mulford B. Foster, who has collected the highest number of bromeliad species both old and new.

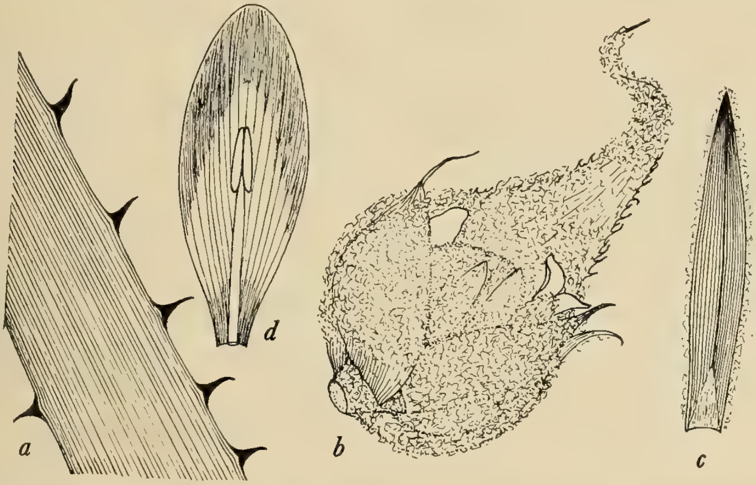

FIG. 1.—*Puya fosteriana*: *a*, Section of leaf-blade, × ½; *b*, inner view of branch and primary bract, × ½; *c*, inner view of sepal, × 1; *d*, petal and stamen, × 1.

ENTOMOLOGY.—*Generic names of the beetle family Oedemeridae and their type species.*[1] ROSS H. ARNETT, JR.,[2] Bureau of Entomology and Plant Quarantine. (Communicated by R. E. Blackwelder.)

It has become an established fact that little can be done to stabilize our zoological nomenclature without the utilization of the genotype (or generotype) concept. Our nomenclature inevitably changes as the increase in our available material and knowledge of the world fauna results in the development of new zoological concepts of particular groups. As an aid to the zoologist confronted with this situation the nomenclaturist has made genotype designations. If the nomenclatural concept of the genus is properly understood by the zoologist and applied with the consciousness that zoological problems are not to be confused with nomenclatorial problems, an important step has been taken toward stabilization of nomenclature without *nomina conservanda.* This process of working out the genotypes of the older genera, and applying the law of priority to the findings, will be, I believe, a means of averting the crisis toward which modern workers are rapidly drifting—a zoological nomenclature buoyed up by the weak foundations of *nomina conservanda.*

The workers of the past three decades have supplied us with a number of genotype catalogues, among which are two that have served as patterns for the present work. Hyslop in 1921 (Proc. U. S. Nat. Mus. **58,** no. 2353) published a genotype catalogue of the Elateridae of the world (Coleoptera), and Pate in 1937 (Mem. Amer. Ent. Soc., no. 9) offered a genotype catalogue of the sphecoid

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[1] Received March 20, 1950.

[2] One cannot do a piece of work of this nature for the first time without becoming indebted to many colleagues for considerable help. To thank publicly all who have contributed time and advice to this project is impossible. However, I feel I must mention V. S. L. Pate, with whom I was associated at Cornell University when this work was begun, and to whom I am indebted for much kind advice and encouragement; and H. S. Barber, of the Bureau of Entomology and Plant Quarantine, who has helped me over many a rough spot during the final stages of the work. My sincere thanks are here expressed to those two men in particular and to others on the staffs of the Division of Insects, of the National Museum, and the Division of Insect Identification of the Bureau of Entomology and Plant Quarantine, of the United States Department of Agriculture, who have helped me in this work.

wasps (Hymenoptera). An attempt has been made to use the best principles of each in developing the following catalogue of the types of the genera of Oedemeridae.

It is difficult to prepare a list of sources of genotype designations that is at all exhaustive; and it is practically impossible to assemble all the earliest genotype designations at one writing. Hence, no list can be considered final or be expected to stabilize all generic names, even on a nomenclatorial basis alone. The following attempt undoubtedly will be found to contain errors, the correction of which will cause reversals in our concepts of particular genera at a later date. However, I have consulted the standard sources for genotype designations with which I am familiar and have catalogued not only the earliest designations I am aware of, but later ones as well, even though these are considered invalid because of prior valid designations. This has been done with the realization that the earliest designation cited, for some reason unknown to me at present, may be invalid; and also with the realization that our code of nomenclature is at present in a state of flux and that changes in rules or interpretations may invalidate certain designations now accepted as valid. If that should happen, the next designation listed might apply, and by citing it here I hope to spare future workers hours of searching through old, inadequately catalogued, and often inaccessible literature. With five exceptions, which are noted in each case, every reference cited has been examined by me.

No attempt is made to indicate generic synonymy other than that resulting when genera are isogenotypic, except in rare cases where the genotypes have been well studied and are known to be synonymous. In all these latter cases, moreover, the authors of the synonymy studied the type specimens of the genotypic species and gave sound reasons for considering the names synonymous on zoological grounds. Only in these few instances has zoology been allowed to creep into this otherwise strictly nomenclatorial paper; and since such synonymy represents only personal opinion a generic name thus synonymized is always available for subsequent resurrection.

It is my intention to follow this catalogue with a series of papers dealing with these genera on zoological grounds. These studies will very probably result in a reduction of the now rather appalling number of generic names in this comparatively small family.

An annotated list of some general references that have been found valuable as sources of genotype designations is appended. These citations are necessarily mentioned repeatedly in the body of the work, but there only the author, date, and page number are given in each case.

In the alphabetical list of the genera that follows I have adopted this sequence of citation: (1) Generic name as originally proposed, with emendations recorded as separate names and listed in the proper alphabetical sequence with cross reference; (2) author's name and year of actual publication [not title-page date, where there is an established difference]; (3) reference to original description, or citation [this in rare cases may be supplemented by an additional reference if the name was originally proposed without included species, in which case the first reference to include species is cited and a note of explanation is given]; (4) the type species listed, either under the combination used in the original description, or that used when the designation was made if there is a difference, in the latter case with the original genus in parentheses following the citation of the original description of the species; this then followed by pertinent synonymy including original reference, reference to first publication of the synonymy, and further references when necessary; (5) the method of type fixation; (6) isogenotypic synonyms and cross references. I have tried to give full explanations of all cases of possible ambiguity; perhaps even to the extent of appearing needlessly verbose to those already familiar with the workings of a genotype catalogue and the methods of nomenclaturists.

In the case of catalogue names, I have considered the genus as validly proposed if accompanied by one or more specific names with the author's name at least as a reference, provided that at least one of the specific names had been validly described.

This catalogue presumes to be correct and complete to December 31, 1948.

GENERA OF OEDEMERIDAE

Aedemera Olivier, 1795, Entomologie 3(50): 1. [Emendation of *Oedemera* Olivier, 1789].

Agasma Newman, 1850, Zoologist **8**: app. cxvi.
Genotype: *Agasma semicrudum* Newman, 1850, *l.c.* cxvii. [Monobasic.]

Allagatha Semenow and Minassain, 1937, Bull. Soc. Ent. France **42**: 227.
Genotype: *Allagatha decora* Semenow and Minassain, 1937, *l.c.* 228. [Monobasic.]

Alloxacis Horn, 1896, Proc. California Acad. Sci. (2) **6**: 385, 395.
Genotype: *Nacerdes dorsalis* Melsheimer, 1846, Proc. Acad. Nat. Sci. Philadelphia **3**: 55. [Designated by Lucas, 1920: 84.]

Alloxantha Seidlitz, 1899, Naturgesch. Ins. Deutschl. **5**(2): 814, 828.
Genotype: *Alloxantha lutea* Seidlitz, 1899, *l.c.* 829. [Designated by Lucas, 1920: 84.]

Anacerda Champion, 1927, Ent. Monthly Mag. **63**: 249.
Genotype: *Anacerda leptidioides* Champion, 1927, *l.c.* 249. [Monobasic.]

Ananca Fairmaire and Germain, 1863 (Aug.), Ann. Soc. Ent. France (4) **3**: 267.
Genotype: *Nacerdes pallens* Solier *in* Gay, 1851, Hist. Chile **5**: 257, pl. 21, figs. 4, 4 a-b. [Designated by Champion, 1917, Ann. Mag. Nat. Hist. (8) **19**: 170.]

Ananconia Seidlitz, 1899, Naturgesch. Ins. Deutschl. **5**(2): 816, 831.
Genotype: *Ananconia martini* (Fairmaire, Bull. Soc. Ent. France, 1896: 224 (*Chitona*). [Designated by Semenow, 1900: 646].

Anancosessinia Kôno, 1937, Ins. Matsum. **11**: 139.
Genotype: *Anancosessinia tarsalis* Kôno, 1937, *l.c.* 140. [Monobasic.]

Anisochroa Semenow, 1900, Horae Soc. Ent. Ross. **34**: 652.
Genotype: *Anisochroa zarudnyi* Semenow, 1900, *l.c.* 653. [Monobasic.]

Anogcodes Dejean, 1834, Cat. Col.: 228.
Genotype: *Anogcodes melanura* (Linnaeus), 1758, Syst. Nat., ed. 10: 403 (*Cantharis*). [Designated by Duponchel, 1841, **1**: 550.] Isogenotypic with *Nacerda* Stevens, 1839.

Anoncodes Redtenbacher, 1845, Gatt. Deutsch. Käfer-fauna: 134. [No author or reference given, but the enlargement of this work, Fauna Austr. 1849: 56, 622, refers the name to *Anogcodes* Dejean, p. 250 (1838), by listing; it is accordingly to be considered an emendation of *Anogcodes*.]

Anoncodes Costa, 1852, Fauna Regni Napoli, Edemer.: 10. [Emendation of *Anogcodes* Dejean, 1834.]

Anoncodina Seidlitz, 1899, Naturgesch. Ins. Deutschl. **5**(2): 765, 786.
Genotype: *Nacerda ruficollis* (Fabricius), 1781, Spec. Ins.: 263 (*Necydalis*). [Present designation.]

Apterosessinia Blair, 1926, Ann. South Afr. Mus. **23**: 357.
Genotype: *Apierosessinia peringueyi* Blair, 1926, *l.c.* 358. [Monobasic.]

Asclera Dejean, 1834, Cat. Col.: 228.
Genotype: *Necydalis sanguinicollis* (Fabricius), 1787, Mant. Ins. **1**: 170. [Present designation.]

Ascleranoncodes Pic, 1915, Echange **31**: 10.
Genotype: *Ascleranoncodes distincticornis* Pic, 1915, *l.c.* 10. [Monobasic.]

Asclerella Semenow, 1900, Horae Soc. Ent. Ross. **34**: 648.
Genotype: *Asclerella tenera* Semenow, 1900, *l.c.* 651. [Monobasic].

Ascleronia Seidlitz, 1899, Naturgesch. Ins. Deutschl. **5**(2): 848, 850, 859.
Genotype: *Asclera semiflava* (Reitter), Deutsche Ent. Zeitschr. 1891: 31 (*Ischnomera*). [Present designation.]

Ascleropsis Seidlitz, 1899, Naturgesch. Ins. Deutschl. **5**(2): 848, 840, 860.
Genotype: *Asclera maculicollis* Ganglbaur, 1890, Horae Soc. Ent. Ross. **24**: 42. [Present designation.]

Asclerosibutia Pic, 1914, Echange **30**: 67.
Genotype: *Asclerosibutia lineaticollis* Pic, 1914, *l.c.* 67. [Present designation.]

Asclerostoma Fleischer, 1919, Ent. Blatt. **15**: 169.
Genotype: *Asclerostoma reitteri* Fleischer, 1919, *l.c.* 169. [Monobasic.]

Baculipalpus Broun, 1880, Man. New Zealand Col. **1**: 423.
Genotype: *Baculipalpus rarus* Broun, 1880, *l.c.* 423. [Monobasic].

Calopus Fabricius, 1775, Syst. Ent.: 182.
Genotype: *Cerambyx serraticornis* Linnaeus, 1758, Syst. Nat., ed. 10: 395. [Designated by Latreille, 1810: 430.] *Calopus serraticornis* Linnaeus, 1758, Syst. Nat., ed. 10: 395 (*Cerambyx*). [Designated by Blanchard, 1844: pl. 53, fig. 6.]

Chitona Schmidt, 1846, Linn. Ent. **1**: 134.
Genotype: *Stenostoma variegata* Germain, 1824, Ins. Spec. Nov.: 167. [Monobasic.] *Chitona connexa* (Fabricius), 1798, Suppl. Ent. Syst.: 153 (*Leptura*). [Designated by Semenow, 1900: 647.] Not an originally included species.

Chromasclera Seidlitz, 1899, Naturgesch. Ins. Deutschl. **5**(2): 848, 850.
Genotype: *Asclera partitipennis* Fairmaire, 1892, Ann. Soc. Ent. Belg. **36**: 158. [Monobasic.]

Chrysanthia Schmidt, 1846, Linn. Ent. **1**: 17, 125. [Emendation of *Chrysarthia* Schmidt, 1844]

Chrysarthia Schmidt, 1844, Cat. Coleopt. Europa, ed. 2: 46. [Not seen.]

Genotype: *Cantharis viridissima* Linnaeus, 1758, Syst. Nat., ed. 10: 403. [Present designation.]

Colobostomus Fairmaire, 1885, Ann. Soc. Ent. France (6) **5**: 452.

Genotype: *Colobostomus griseovestitus* Fairmaire, 1885, *l.c.* 453. [Monobasic.]

Copidita LeConte, 1866, New Species North Amer. Col. **1**: 164.

Genotype: *Probosca quadrimaculata* Motschulsky, 1852, Études Ent. **1**: 78. [Monobasic.]

Copodita Pic, 1923 (and later, consistently!, but no indication that it is a new name), Mél. Exot. Ent. **39**: 32. [Misspelling of *Copidita* LeConte, 1866.]

Cycloderus Solier, 1851, *in* Gay, Hist. Chile **5**: 252.

Genotype: *Cycloderus rubricollis* Solier, 1851, *l.c.* 253. [Monobasic.]

Dammarobius Broun, 1886, Man. New Zealand Col. **4**: 846.

Genotype: *Dammarobius mollis* Broun, 1886, *l.c.* 846. [Monobasic.]

Danerces Westwood, 1875, Trans. Ent. Soc. London, 1875: 228.

Genotype: *Danerces luteicornis* Westwood, 1875, *l.c.* 229. [Present designation.]

Diasclera Reitter, 1913, Deutsche Ent. Zeitschr. 1913: 663.

Genotype: *Diasclera viridescens* Reitter, 1913, *l.c.* 663. [Monobasic.]

Diplectroides Champion, 1889, Biol. Centr.-Amer., Col., **4**(2): 110 [no incl. sp.]; 126 (1890) [first incl. sp.].

Genotype: *Diplectroides longicornis* Champion, 1890, *l.c.* 126. [Original designation.] *Note:* Two included species, but one only provisionally included.

Diplectrus Kirsch, 1866, Berl. Ent. Zeitschr. **10**: 210.

Genotype: *Diplectrus ferrugineus* Kirsch, 1866, *l.c.* 210 [Monobasic.]

Dityloidea Fairmaire and Germain, 1863, Ann. Soc. Ent. France (4) **3**: 277.

Genotype: *Nacerdes janthina* Fairmaire and Germain, 1861, Col. Chile **2**: 6. [Monobasic.]

Ditylonia Seidlitz, 1899, Naturgesch. Ins. Deutschl. **5**(2): 814, 827.

Genotype: *Ditylus cephalotes* Champion, 1889, Biol. Centr.-Amer., Col., **4**(2): 119, pl. 5, fig. 23. [Designated by Lucas, 1920: 245.]

Ditylus Fischer-Waldheim, 1817, Mem. Soc. Imp. Moscow **5**: 469. [No included named species, but a species is figured, pl. 15A, 1–6.] Dejean, 1821, Cat. Coleop.: 72. [*Ditylus* Fischer-Waldheim referred to, with *laevis* Fabricius the only included species. *Helops* is in parentheses after Fabricius's name, which refers this to Fabricius, 1792, Ent. Syst. **1**(2): 120. This is then the first included species.]

Genotype: *Helops laevis* Fabricius, 1792, Ent. Syst. **1**(2): 120. [Monobasic.] *Note:* Next reference to this genus is Fischer-Waldheim, 1820–22, Ent. Imp. Russ. **1**: 31, [Not seen.] Sherborn gives the date of this page as May 1822.

ADDITIONAL GENOTYPE DESIGNATIONS: *Dytilus ruficollis* (Fabricius), 1781, Spec. Ins.: 263 (*Necydalis*). [Designated by Blanchard, 1844, pl. 53, fig. 8.] *Dytilus* Blanchard, 1844, is a misspelling of *Ditylus* Fischer-Waldheim, 1817. This is an invalid designation because it is not one of the first included species.

Ditylus helopioides Fischer-Waldheim, 1822 (May), Ent. Imp. Russ. **1**: 31, pl. 5, fig. 1a–b. (Supposedly this paper refers to the figure in Fischer-Waldheim, 1817, cited above, and the species is usually cited as dating from 1817, but I have been unable to see this publication and therefore cannot verify this supposition). [Designated by Duponchel, 1845, **5**: 89.]

Ditylus helopioides Fischer-Waldheim, 1817 [according to Crotch]. [Designated by Crotch, 1870: 229.] *Note: Ditylus helopioides* Fischer-Waldheim is a synonym of *Helops laevis* Fabricius, 1792, Ent. Syst. **1**(2): 120, according to Germar, 1821, Mag. der Ent. **4**: 401.

Synonym by genotype synonymy: *Mimetes* Eschscholtz, 1818.

Isogenotypic: *Microps* Megerle, 1821.

Diversipalpus Pic, 1938, Mel. Exot.-Ent. **70**: 22.

Genotype: *Schistopselaphus bicoloripes* Pic, 1938, *l.c.* 22. [Monobasic.]

Dohrnia Newman, 1851, Zoologist **9**: app. CXXXIII.

Genotype: *Dohrnia miranda* Newman, 1851, *l.c.* CXXXIII. [Monobasic.]

Dolichopyga Seidlitz, 1899, Naturgesch. Ins. Deutschl. **5**(2): 816, 832.

Genotype: *Dolichopyga acuminata* Reitter, Deutsche Ent. Zeitschr. 1890: 152 (*Probosca*). [Designated by Semenow, 1900: 647.]

Dolychopyga Lucas, 1920, p. 247. [Emendation of *Dolichopyga* Seidlitz, 1899.]

Dryopomera Fairmaire, 1897, Notes Leyden Mus. **18**: 238.
Genotype: *Dryops indica* Fairmaire, 1896, Ann. Soc. Ent. Belg. **40**: 54. [Monobasic.]

Dytilus Blanchard, 1844, Règ. Animal: pl. 53, fig. 8. [Misspelling of *Ditylus*.]

Eobia Semenow, 1894, Horae Soc. Ent. Ross. **28**: 455.
Genotype: *Asclera cinereipennis* Motschulsky, 1866, Bull. Moscou. **39**: 173. [Present designation.]

Exocalopus Broun, 1893, Man. New Zealand Col. **5**: 1170.
Genotype: *Exocalopus pectinatus* Broun, 1893, *l.c.* 1170. [Monobasic.]

Ezonacerda Kôno, 1934, Ins. Mats. **9**: 28.
Genotype: *Oedemera nigripennis* Matsumura, 1911, Journ. Coll. Sapporo **4**: 128. [Original designation and monobasic.]

Falsonerdanus Pic, 1943, Echange **59**: 7.
Genotype: *Falsonerdanus nigronotatus* Pic, 1943, *l.c.* p. 7. [Present designation.] *Note:* According to a strict interpretation of the Code, this genus is invalid because no genotype was originally designated. The present designation will, of course, validate the name.

Falsosessinia Pic, 1923, Mél. Exot.-Ent. **39**: 28.
Genotype: *Falsosessinia spinosa* Pic, 1923, (*l.c.* 29. [Present designation.]

Fissilamoncodes Neave, 1939, Nomen. Zool. **2**: 409. [Misspelling of *Fissilanoncodes* Pic, 1912.]

Fissilanoncodes Pic, 1912, Mél. Exot.-Ent. **1**: 4.
Genotype: *Fissilanoncodes maculicollis* Pic, 1912, *l.c.* p. 4. [Monobasic.]

Fissilonacerdes Pic, 1935, Mél. Exot.-Ent. **66**: 21.
Genotype: *Fissilonacerdes javanus* Pic, 1935, *l.c.* p. 21. [Present designation.] See note under *Falsonerdanus* Pic.

Ganglbaueria Semenow, 1891, Horae Soc. Ent. Ross. **25**: 378.
Genotype: *Ganglbaueria collaris* Semenow, 1891, *l.c.* p. 379. [Monobasic.]

Holoxantha Semenow, 1894, Horae Soc. Ent. Ross. **28**: 457, 470.
Genotype: *Ditylus concolor* Brullé, 1838, *in* Webb and Berthelot, Hist. Nat. Canar. Col.: 70, pl. 1, fig. 13. [Original designation.]

Homomorpha Semenow, 1898, Wien. Ent. Zeit. **17**: 177.
Genotype: *Homomorpha crucifera* Semenow, 1898, *l.c.* 177. [Monobasic and original designation.]

Hypasclera Kirsch, 1866, Berl. Ent. Zeitschr. **10**: 210.
Genotype: *Hypasclera schistacea* Kirsch, 1866, *l.c.* 211. [Monobasic.]

Idgiomima Blair, 1926, Ann. South Afr. Mus. **23**: 373.
Genotype: *Asclerosibutia* (*Idgiomima*) *neavei* Blair, 1926, *l.c.* 373. [Original designation.]

Idgiomimula Blair, 1926, Ann. South Afr. Mus. **23**: 374.
Genotype: *Asclerosibutia* (*Idgiomimula*) *terminalis* Blair, 1926, *l.c.* 374. [Original designation and monobasic.]

Indanerces Pic, 1923, Mél. Exot. Ent. **39**: 24.
Genotype: *Indanerces nitidicollis* Pic, 1923, *l.c.* 24. [Present designation.]

Ischnomera Stephens, 1832, Ill. Brit. Ent., Mandib., **5**: 53.
Genotype: *Necydalis caerulea* Linneaus, 1767, Syst. Nat., ed. 12: 642. [Designated by Westwood, 1838: 31, appendix.]
Isogenotypic with *Oedemera* Olivier, 1789, and *Stenolytra* Dillwyn, 1829.

Isoloxantha Semenow, 1902, Rev. Russe Ent. **2**: 353. [New name proposed for *Xanthomima* Semenow, 1900 (not Warren, 1897).]

Ithaca Olliff, 1887, Proc. Linn. Soc. New South Wales (2) **2**: 153.
Genotype: *Ithaca anthina* Olliff, 1887, *l.c.* 154. [Monobasic.]

Lepturidea Fauvel, 1862, Bull. Soc. Linn. Normandie **7**: 150.
Genotype: *Lepturidea deplanchei* Fauvel, 1862, *l.c.* 152, pl. 10, figs. 32–39. [Monobasic.]

Lethonymus Marseul, 1857, Cat. Col. Eur.: 130
Genotype: *Lethonymus difformis* Marseul, 1857, *l.c.* 130. *Note:* The species *difformis* was described by Schmidt, 1846, Linn. Ent. **1**: 90, without a generic name but as genus no. 10. On page 17, *l.c.*, it is referred to as "10. n.g. anonym."[3] Marseul validated *difformis* by proposing the generic name *Lethonymus* [means "forgotten name"] and using *difformis* with it and at the same time referring to Schmidt, 1846. [Marseul publication not seen, not available in North America, but reprint in L'Abeille, 1867: 91, consulted.] [Monobasic.]

Loboglossa Solier, 1851, *in* Gay, Hist. Chile **5**: 254.
Genotype: *Loboglossa variipennis* Solier, 1851, *l.c.* 255. [Monobasic.]

Matusinhosa Pic, 1923, Mél. Exot. Ent. **39**: 27.
Genotype: *Matusinhosa maculata* Pic, 1923, *l.c.* 27. [Present designation.]

Mecopselaphus Solier, 1849, *in* Gay, Hist. Chile **4**: 430.

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[3] Inasmuch as Schmidt died in 1843, and his monograph did not appear until 1846, it appears that the manuscript was incomplete at this point.

Genotype: *Mecopselaphus maculicollis* Solier, 1849, *l.c.* 430. [Present designation.] *Note:* This is probably not an oedemerid.

Melananthia Blair, 1926, Ann. South Afr. Mus. **23:** 354.

Genotype: *Melananthia costipennis* Blair, 1926, *l.c.* 355. [Original designation.]

Meloeditylus Pic, 1926, Mél. Exot. Ent. **47:** 31.

Genotype: *Meloeditylus reductus* Pic, 1926, *l.c.* 31. [Monobasic.]

Metasclera Broun, 1914, Bull. New Zealand Inst. **1:** 198.

Genotype: *Metasclera nigricans* Broun, 1914, *l.c.* 198. [Present designation.]

Micronacerdes Pic, 1923, Mél. Exot. Ent. **39:** 25.

Genotype: *Micronacerdes latefasciatus* Pic, 1923, *l.c.* 25. [Present designation.]

Microps Megerle, 1821 *in* Dejean (not Megerle *in* Dahl, 1823; Wagler, 1828; Stevens or Fischer-Waldheim, 1829; Wagler, 1830; Agassiz, 1833; Haliday, 1833; or Hallowell, 1856), Cat. Coleop.: 72.

Genotype: *Helops laevis* Fabricius, 1792, Ent. Syst. **1**(2): 120. [Monobasic.]

Note: Absolute synonym of *Ditylus* Fischer-Waldheim, 1817, because it was originally proposed as a synonym.

Microsessinia Pic, 1922, Mél. Exot. Ent. **35:** 18.

Genotype: *Microsessinia cyanescens* Pic, 1922, *l.c.* 18. [Present designation.]

Milneum Pic, 1923, Mél. Exot. Ent. **39:** 25.

Genotype: *Milneum inaequale* Pic, 1923, *l.c.* 25. [Monobasic.]

Mimetes Eschscholtz, 1818, Mem. Acad. Pétersb. **6:** 467.

Genotype: *Mimetes unicolor* Eschscholtz, 1818, *l.c.* 468. [Monobasic.] *Note:* Synonym by genotype synonymy: *Ditylus* Fischer-Waldheim, 1817. *Helops laevis* Fabricius, 1792, Ent. Syst. **1** (2): 120, is a synonym of *Mimetes unicolor* Eschscholtz, 1818, Mem. Acad. Pétersb. **6:** 467, according to Germar, 1821, Mag. der Ent. **4:** 401.

Mimodiplectrus Pic, 1923, Mél. Exot. Ent. **39:** 27.

Genotype: *Mimodiplectrus cyaneipennis* Pic, 1923, *l.c.* 27. [Monobasic.]

Mimoncomera Pic, 1923, Mél. Exot. Ent. **39:** 28.

Genotype: *Mimoncomera ocularis* Pic, 1923, *l.c.* 28. [Monobasic.]

Mimoselenopalpus Pic, 1924, Mél. Exot. Ent. **42:** 22.

Genotype: *Mimoselenopalpus bicoloriceps* Pic, 1924, *l.c.* 22. [Monobasic.]

Morpholycus Lea, 1917, Trans. Royal Soc. South Australia **41:** 287.

Genotype: *Morpholycus apicalis* MacLeay, 1872, Trans. Ent. Soc. New South Wales **2:** 313 (*Pseudolychus*). [Present designation.]

Nacerdes Dejean, 1834, Cat. Col.: 228.

Genotype: *Necydalis notata* Fabricius, 1775, Ent. Syst. **1**(2): 353. (Synonym of *Cantharis melanura* Linnaeus, 1758, Syst. Nat., ed. 10: 403, according to W. Schmidt, 1846, Linn. Ent. **1:** 29.) [Present designation.] *Note:* Synonyms by genotype synonymy: *Anogcodes* Dejean, 1834, and *Nacerda* Stevens, 1839. [*Nacerdes* is valid by position priority.]

Nacerda Faldermann, 1837, N. Mém. Soc. Imp. Nat. Moscou **5:** 139. [Not Seen.]

Nacerda Stevens, 1839, Man. Brit. Col., Mandib., **1:** 337.

Genotype: *Cantharis melanura* Linnaeus, 1758, Syst. Nat., ed. 10: 403. [Monobasic.] Isogenotypic with *Anogcodes* Dejean, 1834.

Nacerdasclera Munster, 1921, Norsk Ent. Tidsskr. **1:** 8.

Genotype: *Asclera* (*Nacerdasclera*) *sibirica* (Gebler), 1847, Bull. Moscou **20**(4): 510 (*Anoncodes*) (= *Oedemera sibirica* Gebler, 1830, *in* Ledebour, Reisen Altai **2**(3): 132). [Monobasic.] *Note:* This synonymy is as listed by Munster, *l.c.*

Nacerdochroa Reitter, 1893, Wien. Ent. Zeit. **12** 113.

Genotype: *Nacerdochroa plustschevskyi* Reitter, 1893, *l.c.* 114. [Monobasic.]

Nacerdoscuta Pic, 1915, Mél. Exot. Ent. **13:** 6.

Genotype: *Nacerdoscutass emirufa* Pic, 1915: *l.c.* 6. [Monobasic.]

Nerdanus Fairmaire, 1896, Notes Leyden Mus. **18:** 239.

Genotype: *Nerdanus coeruleus* Fairmaire, 1896, *l.c.* 239. [Monobasic.]

Ocularium Pic, 1922, Mél. Exot. Ent. **36:** 18.

Genotype: *Ocularium rufum* Pic, 1922, *l.c.* 18. [Monobasic.]

Oedechira Motschulsky, 1872, Bull. Moscou **45**(pt. 2): 54.

Genotype: *Oedechira paradoxa* Faldermann, 1837, Fauna Ent. Transc.: 147. [Present designation.] *Note:* Motschulsky says this is not the same as *Anoncodes adusta* Panzer [genotype of *Pachychirus* Redtenbacher, 1945], which was placed in synonymy by M. Mulsant.

Oedemera Olivier, 1789, Enc. Méth. **4**(1): 31. [No incl. sp., but a full description is given. The species were to follow in a later part; however, vol. 3 of "Entomologie" appeared before. There Olivier changed the spelling of *Oedemera* to *Aedemera* and included the first species, without reference to his 1789 publication. However, he later uses *Oedemera* again and refers to the 1795 publication.] Olivier, 1795, Entomologie **3**(50): 1. [First incl. sp.]

Genotype: *Necydalis caerulea* Linnaeus, 1767, Syst. Nat., ed. 12: 642. [Designated by Latreille, 1810: 430; Curtis, 1832, British Ent. **2**: pl. 390.] *Necydalis coerulea* Fabricius, 1775, Syst. Ent.: 209. [Designated by Westwood, 1838: 31 (appendix).] *Necydalis coerulea* Fabricius, 1775, Syst. Ent.: 209. [Designated by Blanchard, 1844, pl. 53, fig. 9.] *Oedemera femorata* Fabricius, 1792, Ent. Syst. **1**(2): 74 (*Dryops*). [Designated by Crotch, 1870: 48; invalid, not an originally included species.]

Isogenotypic with *Ischnomera* Stephens, 1832, and *Stenolytra* Dillwyn, 1829.

Oedemerastra Seidlitz, 1899, Naturgesh. Ins. Deutschl. **5**(2): 906, 923.

Genotype: *Oedemera* (*Oedemerastra*) *podagrariae* (Linnaeus) 1767, Syst. Nat., ed. 12: 642 (*Necydalis*). [Present designation.] Isogenotypic with *Oncomera* Stephens, 1829.

Oedemerella Seidlitz, 1899, Naturgesch. Ins. Deutschl. **5**(2): 907, 933.

Genotype: *Oedemera* (*Oedemerella*) *croceicollis* Gyllenhall, 1827, Ins. Svec. **4**: 523 (appendix). [Monobasic.]

Oedemerina Costa, 1852, Fauna Regni Napoli, Edemer.: 31.

Genotype: *Oedemerina lurida* (Gyllenhall), 1810, Ins. Svec. **2**: 639 (*Necydalis*) (= by reference, *Necydalis lurida* Marsham, 1802, Ent. Brit.: 360). [Monobasic.]

Oedemeronia Seidlitz, 1899, Naturgesch. Ins. Deutschl. **5**(2): 906, 919.

Genotype: *Necydalis flavipes* Fabricius, 1792, Ent.Syst. **1**(2): 355. [Monobasic.]

Oncomera Stephens, 1829, Nomencl. British Ins.: 20; Syst. Cat. Brit. Ins.: 251 (Aug.).

Genotype: *Necydalis podagrariae* Linneaus, 1767, Syst. Nat., ed. 12, **2**: 642. [Monobasic.] *Necydalis podagrariae* Linneaus, 1767, *l.c.* [Designated by Westwood, 1838: 31 (appendix) for *Oncomera* Stephens, 1832, which is referable to Stephens, 1829.]

Isogenotypic with *Oedemerastra* Seidlitz, 1899.

Oncomerella Reitter, 1911, Fauna Germ. **3**: 406 (note).

Genotype: *Oncomera marmorata* Erichson, 1841, Wagner's Reise Algier **3**: 229 (*Oedemera*). [Monobasic.]

Oncomerina Seidlitz, 1899, Naturgesch. Ins. Deutschl. **5**(2): 884, 885, 891.

Genotype: *Oedemera murinipennis* Kiesenwetter, 1859, Berl. Ent. Zeitschr. **3**: 192, pl. 3, fig. 9. [Monobasic.]

Opsimea Miller, 1880, Verh. zool.-bot. Ges. Wien **30**: 224.

Genotype: *Opsimea ventralis* Miller, 1880, *l.c.* 225. [Monobasic.]

Oschaninia Semenow, 1898, Wien. Ent. Zeit. **17**: 175.

Genotype: *Ganglbaueria wilkinsi* Heyden, Deut. Ent. Zeit., 1894: 52, fig. [Original designation and monobasic.]

Oxacis LeConte, 1866, New Species North Amer. Col. **1**: 165.

Genotype: *Asclera cana* LeConte, 1854, Proc. Acad. Nat. Sci. Philad. **7**: 225. [Present designation.]

Pachychirus Redtenbacher, 1845, Gatt. Deut. Käfer-fauna: 134, 156.

Genotype: *Necydalis adusta* Panzer, 1795, Deutschl. Insectenfaune: 279. [Monobasic.]

Patiala Lewis, 1895, Ann. Mag. Nat. Hist. (6) **15**: 434.

Genotype: *Patiala antennata* Lewis, 1895, *l.c.* 434. [Original designation.]

Peronocnemis Fairmaire, 1886, Ann. Soc. Ent. France (6) **6**: 352.

Genotype: *Peronocnemis davidis* Fairmaire, 1886, *l.c.* 352. [Monobasic.]

Perocnemis Schenkling, 1915, Col. Cat. **65**: 12. [Emendation.]

Phytilea Broun, 1893, Man. New Zealand Col. **5**: 1171.

Genotype: *Phytilea propera* Broun, 1893, *l.c.* 1172. [Monobasic.]

Piras Champion, 1889, Biol. Centr.-Amer., Col., **4** (2): 110 (1889) [no incl. sp.], 164 (1890) [first incl. sp.].

Genotype: *Piras nasalis* Champion, 1890, *l.c.* 165. [Present designation.]

Platelytra Gemminger and Harold, 1870, Cat. Col. **7**: 2166. [Emendation of *Platylytra* Fairmaire and Germain, 1863.]

Platylytra Fairmaire and Germain, 1863, Ann. Soc. Ent. France (4) **3**: 278.

Genotype: *Platylytra vitticollis* Fairmaire and Germain, 1863, *l.c.* 279. [Monobasic.]

Probosca Schmidt, 1846, Linn. Ent. **1**: 17, 130.

Genotype: *Probosca viridana* Schmidt, 1846, *l.c.* 130 (*Nacerdes*). [Designated by Semenow, 1900, p. 647.]

Proboscea Schmidt, 1846, *l.c.* p. 131. [Probably a misspelling of *Probosca*.]

Pselaphanca Blair, 1927, Ann. Mag. Nat. Hist. (9) **20**: 165.

Genotype: *Selenopalpus lateritius* Fairmaire, Rev. Zool., 1849: 457. [Original designation.]

Pseudananca Blackburn, 1893, Trans. Royal Soc. South Australia **17:** 135.
Genotype: *Pseudananca ruficollis* Blackburn, 1893, *l.c.* 135. [Monobasic.]

Pseudolycus Guérin, 1833, Ann. Soc. Ent. France **2:** 155.
Genotype: *Pseudolycus marginatus* Guérin, 1833, *l.c.* 156, pl. 7, A, figs. 1–6. [Present designation.]

Pseudonerdanus Pic, 1923, Mél. Exot. Ent. **39:** 24.
Genotype: *Pseudonerdanus luteonotatus* Pic, 1923, *l.c.* 24. [Monobasic.]

Rhinoplatia Horn, 1868, Trans. Amer. Ent. Soc. **2:** 137.
Genotype: *Rhinoplatia ruficollis* Horn, 1868, *l.c.* 138. [Monobasic.]

Rhopalobrachium Boheman, 1858, Eugen. Resa, Ins.: 109.
Genotype: *Rhopalobrachium clavipes* Boheman, 1858, *l.c.* 110, pl. 1, fig. 8, 8a–g. [Monobasic.]

Saloninus Fairmaire, 1891, Ann. Soc. Ent. Belg. **35:** Bull: CXXXIII.
Genotype: *Saloninus nebulosus* Fairmaire, 1891, *l.c.* CXXXIII. [Original designation.]

Schellia Reitter, 1914, Ent. Blatt. **10:** 49.
Genotype: *Schellia sitaroides* Reitter, 1914, *l.c.* 50 [Monobasic.]

Schistopselaphus Fairmaire, 1896, Notes Leyden Mus. **18:** 126.
Genotype: *Schistopselaphus apicatus* Fairmaire, 1896, *l.c.* 127. [Monobasic.]

Selenopselaphus Gemminger and Harold, 1870, Cat. Col. **7:** 2168. [Emendation of *Selenopalpus* White, 1846.]

Selenopalpus White, 1846, Voy. *Erebus* and *Terror*, Ins.: 13.
Genotype: *Selenopalpus chalybaeus* White, 1846, *l.c.* 13. [Present designation.]

Sessinia Pascoe, 1863 (Jan.), Journ. Ent. **2:** 45.
Genotype: *Nacerdes livida* Fabricius, 1775, Syst. Ent.: 124 (*Lagria*). [Designated by Semenow, 1894: 458.]

Sisenes Champion, 1889, Biol. Centr.-Amer., Col. 4(2): 111 (1889) [no incl. sp.], 130 (1890) [first incl. sp.].
Genotype: *Sisenes suturalis* Champion, 1890, *l.c.* 141, pl. 6, fig. 23. [Present designation.]

Sisenopiras Pic, 1923, Mél. Exot. Ent. **39:** 26.
Genotype: *Sisenopiras gounellei* Pic, 1923, *l.c.* 26. [Present designation.]

Sparedropsis Heyden, 1886, Deutsche Ent. Zeitschr. **30:** 191.
Genotype: *Sparedropsis fuscus* Heyden, 1886, *l.c.* 191. [Monobasic.]

Sparedrus Dejean, 1821, Cat. Col.: 72.
Genotype: *Calopus testaceus* Andersch, 1797, *in* Hoppe, Ent. Taschenbuch: 165. [Monobasic.] *Sparedrus testaceus* Schoenherr, 1817 (refers to Andersch, 1797). [Designated by Blanchard, 1844: pl. 53, fig. 7.]

Spharedrus Kuhnt, 1912, Ill. Best.-Tab. Käf. Deutschl.: 689, 690. [Misspelling of *Sparedrus* Dejean.]

Stenaxis Schmidt, 1846, Linn. Ent. **1:** 17, 87.
Genotype: *Oedemera annulata* Germar, 1824, Ins. Spec. Nov.: 166. [Monobasic.]

Stenolytra Dillwyn, 1829, Mem. Col. Ins. Swansea: 61.
Genotype: *Stenolytra caerulea* (Linnaeus), 1767, Syst. Nat., ed. 12: 642 (*Necydalis*). [Monobasic.] *Note:* The title page of Dillwyn's publication states "Not Published." However, it was printed and copies are available.
Isogenotypic with *Oedemera* Olivier, 1789, and *Ischnomera* Stephens, 1832.

Stenostoma Latreille, 1810, Consid. Gen.: 217.
Genotype: *Leptura rostrata* Fabricius, 1787, Mant. Ins. **1:** 159 (*Lagria*). [Designated by Latreille, 1810: 430; Crotch, 1870: 223.]

Stenostomidea Perroud, 1864, Ann. Soc. Linn. Lyon **11:** 126.
Genotype: *Stenostomidea grevilleae* Perroud, 1864, *l.c.* 127. [Monobasic.]

Techmessa Bates, 1874, Ann. Mag. Nat. Hist. (4) **13:** 113.
Genotype: *Techmessa concolor* Bates, 1874, *l.c.* 113. [Present designation.]

Techmessodes Broun, 1893, Man. New Zealand Col. **5:** 1173.
Genotype: *Techmessodes versicolor* Broun, 1893, *l.c.* 1173. [Monobasic.]

Thaccona Walker, 1859, Ann. Mag. Nat. Hist. (3) **3:** 260.
Genotype: *Thaccona dimelaena* Walker, 1859, *l.c.* 260. [Monobasic.]

Thelyphassa Pascoe, 1876, Ann. Mag. Nat. Hist. (4) **18:** 58.
Genotype: *Thelyphassa diaphana* Pascoe, 1876, *l.c.* 58. [Monobasic.]

Trichananca Blackburn, 1891, Trans. Royal Soc. South Australia **14:** 341.
Genotype: *Trichananca victoriensis* Blackburn, 1891, *l.c.* 341. [Monobasic.]

Uroplatosisenes Pic, 1934, Mél. Exot. Ent. **63:** 23.
Genotype: *Uroplatosisenes depressicornis* Pic, 1934, *l.c.* 24. [Present designation.] *Note:* Strict interpretation of the Code makes this genus invalid because no genotype was originally designated. However, it is here accepted. See note under *Falsonerdanus* Pic.

Vasaces Champion, 1889, Biol. Centr.-Amer., Col. 4 (2): 111 (1889) [no incl. sp.], 128 (1890) [first incl. sp.].

Genotype: *Vasaces aeneipennis* Champion, 1890, *l.c.* 128, pl. 6, figs. 7, 7a–c. [Present designation.]

Vodomarus Champion, 1889, *l.c.* 111 (1889) [no incl. sp.], 143 (1890) [first incl. sp.].

Genotype: *Vodomarus quadrifoveolatus* Champion, 1890, *l.c.* 143. [Monobasic.]

Xanthochroa Schmidt, 1846, Linn. Ent. **1**: 17, 35.

Genotype: *Oedemera carniolica* Gistl, 1832, Faunus **1**: 150. [Present designation.]

Xanthochroina Ganglbaur, 1881, Verh. zool.-bot. Ges. Wien **31**: 98, 105.

Genotype: *Xanthochroina auberti* Abeille, Bull. Soc. Ent. France, 1876: CLXVI. [Monobasic.]

Xanthomima Semenow, 1900 [not Warren, 1897]. (See *Isoloxantha* Semenow, 1902, Horae Soc. Ent. Ross. **34**: 646, which replaces this name.)

Genotype: *Xanthomima handlirschi* (Seidlitz), 1899, Naturgesch. Ins. Deutschl. **5**(2): 832 (*Ananconia*). [Original designation and monobasic.]

Zabriola Fairmaire, 1901, Rev. Ent. **20**: 198.

Genotype: *Zabriola obscurifrons* Fairmaire, 1901, *l.c.* 198. [Monobasic.]

Zoubkovia Seidlitz, 1899, Naturgesch. Ins. Deutschl. **5**(2): 815. [Misspelling of *Zubkovia* Semenow, 1894; correctly spelled and refers to Semenow, 1894, on p. 830.]

Zubkovia Semenow, 1894, Horae Soc. Ent. Ross. **28**: 454, 455, 467.

Genotype: *Zubkovia turcomanica* Semenow, 1894, *l.c.* 468. [Monobasic.]

THE MORE IMPORTANT PUBLICATIONS GIVING GENOTYPE DESIGNATIONS FOR GENERA OF OEDEMERIDAE

Latreille, P. A. *Considérations générales sur l'ordre naturel des animaux*. . . 444 pp. Paris, 1810. [The appendix of this work lists genotypes. They are valid only where one name is listed, or if two or more are listed, the first name must be set off by the word "eujud." All others are here considered as not valid. (See Opinion Nos. 11 and 136.)]

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Blanchard E. *In* Cuvier, G. [Disciples' edition of], *Le règne animal*. Paris, 1844. [The title page of this series states that the species figured is the type of the genus illustrated. Sherborn, C. D., 1922, Ann. Mag. Nat. Hist. (9) 10: 555–556) says that pages 324–340 (Oedemeridae there included) were issued in 1844.]

Crotch, G. R. *The genera of Coleoptera studied chronologically (1735–1801)*. Trans. Ent. Soc. London, 1870: 41–52; *The genera of Coleoptera studied chronologically (1806–21)*, ibid.: 213–241. 1870. [Crotch attempts to designate genotypes, particularly in the second part, some of which are valid and many of which are not.]

Semenow, Andrea. *Symbolae ad cognitionem oedemeridarum*. Horae Soc. Ent. Ross. **28**: 449–474. 1894.

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ZOOLOGY.—*Description of a new species of amphipod of the genus* Corophium *from Adyar, Madras, India.*[1] K. Nagappan Nayar, University of Madras, S. India. (Communicated by Waldo L. Schmitt.)

Barnard (1935), Chilton (1921), Giles (1885, 1888, 1890), Stebbing (1940), and Walker (1904, 1905, 1909) have listed and described over 120 species of amphipods from Indian waters. While studying a collection of over 40 forms from the Madras coast, the author found the present form to be a new species. Of the 37 species known of the tube-dwelling genus *Corophium*, two have been recorded from India. The present form, the third species, is the first to be recorded from Madras. Hence a full account of this new species and a comparison with the other Indian species were deemed fitting.

Large numbers of both males and females of this amphipod are found living in the muddy bottom of the Adyar brackish water (under the San Thome Bridge). The females are more numerous than the males. These amphipods occur through out the year and are hardy enough to withstand the dilution of the medium when the river is cut off from the sea from April to October.

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[1] Received May 8, 1950.

Corophium madrasensis, n. sp. Fig. 1

Male.—Head with front between the side lobes straight, slightly convex, or with a very low central obtuse-angular projection; eyes dark, small, and slightly oval. The side plates of the first peraeon segment are apically fringed with three plumose setae. Antenna 1 reaching beyond the proximal end of the fifth joint of antenna 2; inner margin of the first joint fringed with rather long setae but without spines; the second joint a little shorter than the first and slightly more than twice as long as the third; flagellum not quite so long as the peduncle and composed of about 12 joints. Antenna 2, fourth joint more than twice as long as the third with lower margin produced distally into a strong forward-curving tooth below and a small tooth above; and a low narrow tooth or ridge at the lower inside surface at the proximal end; fifth joint nearly as long as the fourth; flagellum composed of one long and two short joints; the lower margins of the third, fourth, and fifth peduncular joints and the flagellum bear groups of long setae. First joint of the mandibular palp not produced distally where the characteristic plumose seta is borne. Second joint longer than the first.

The first gnathopod with the third and fifth joints densely setose, the fifth tapering distally, the palm slightly oblique, convex and front margin of joint fringed with slender spines; the seventh joint smooth and curved. The second gnathopod has the fourth joint fringed with the customary double row of extremely long setae and the seventh joint with three broad teeth.

Peraeopods 1 and 2, second and fourth joints moderately expanded; seventh joint as long as the sixth. Peraeopods 3 and 4 normal. Peraeopod 5 reaching beyond uropod 1, second joint well expanded and fringed on rear margin with long plumose setae.

The peduncle of uropod 1 has a pointed triangular cone at its distal end and a row of about four spines on outer margin and three spines on the inner margin. The outer ramus has three spines on outer edge besides the four or five terminal spines and without any spines on the inner margin. The inner ramus has three lateral spines on the outer margin in addition to the three terminal spines and no spines on the inner margin. The peduncle of uropod 2 is smaller in size and has one thin spine at the distal end on the outer side. The rami are subequal in length and have no spines on their inner margins. The outer ramus has two lateral spines on its outer margin while the inner ramus bears only the terminal spines. Uropod 3 is very short. The ramus is shorter than the peduncle; one or two small and slender spines arise from the distal end of the inner margin of the peduncle. The ramus is provided distally with eight or nine long slender spines. Telson triangular, with obtusely pointed apex. Length of the male from front of the head to the end of uropods about 4.5 mm.

Female.—The female differs from the male principally in antenna 1 and antenna 2 and also in the number of spines in the uropods. Antenna 1 reaching to the distal end of the fifth joint of antenna 2; inner margin of first joint of peduncle bears three proximal spines and a few small setae; lower margin bears two to five distal forward-pointing spines; flagellum slightly shorter than the peduncle and composed of about eight to nine joints. Antenna 2, much smaller and not so strong as in male; the third joint bears two small spines at the lower distal end; fourth joint has four spines along the lower edge and two spines on the inner surface. The fifth joint is setose but devoid of any spines on the inner margin but has a large number of long setae. Flagellum composed of one long and one or two short joints. Gnathopods and peraeopods are like those of the male.

The peduncle of uropod 1 is produced distally into a triangular lobe as in the male; the outer margin bears five or six spines and inner margin with four spines. Outer ramus has four spines on outer margin and without any spines on the inner margin. The inner ramus has four spines on the outer margin and no spines on the inner margin. The peduncle of uropod 2 with two small spines at the distal end. The outer ramus has four spines on the outer margin and the inner ramus with one spine on the outer margin. Both rami without spines on their inner margins. Uropod 3 is like that of the male.

Type.—A male, U.S.N.M. no. 90736, taken in the muddy bottom of the Adyar, brackish water (under the San Thome Bridge), Madras, India, by K. Nagappan Nayar.

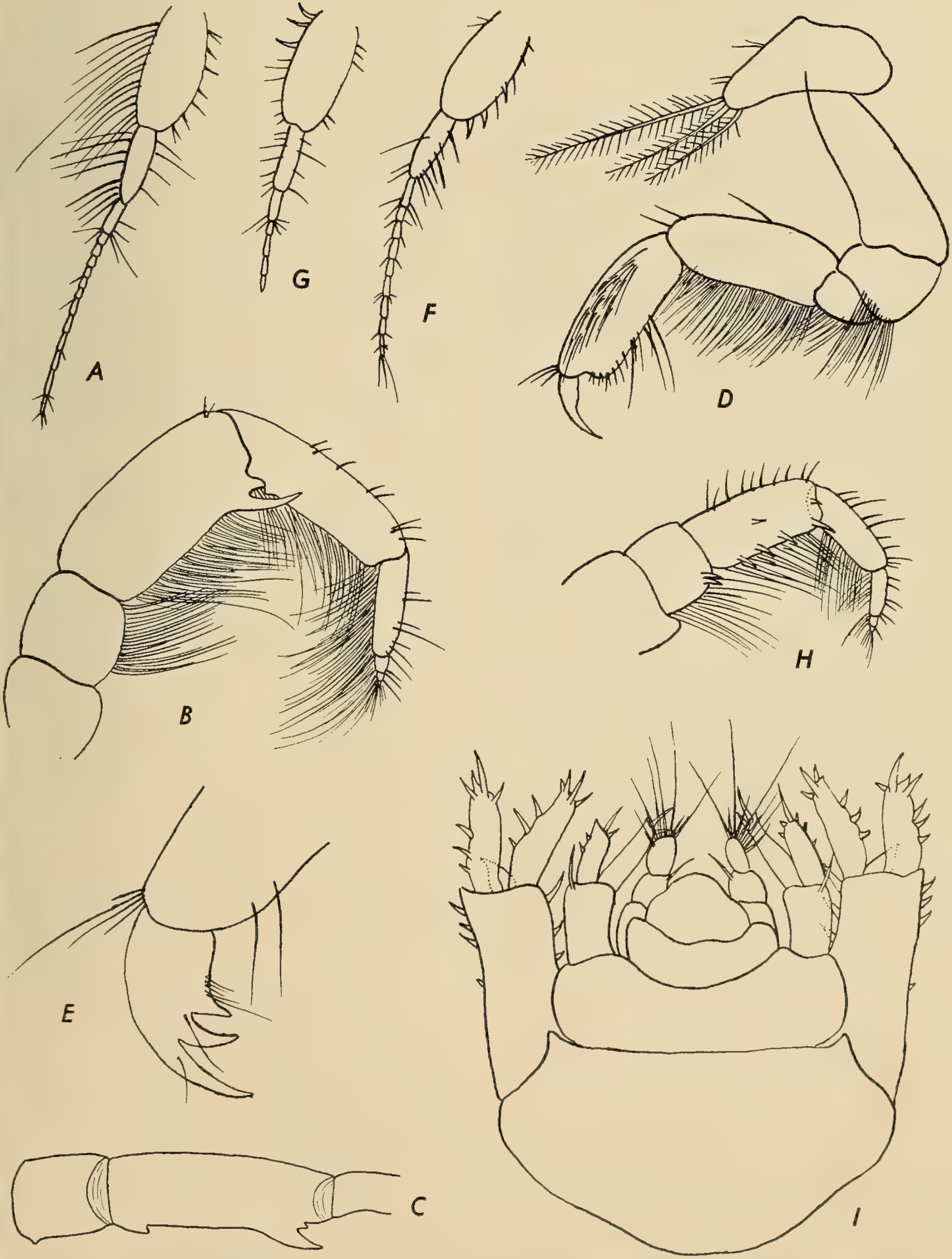

FIG. 1.—*Corophium madrasensis*, n. sp.: Male: *a*, Left antenna 1 from above, × 45; *b*, left antenna 2, side view, × 45; *c*, right antenna 2 from below, × 45; *d*, gnathopod 1, × 90; *e*, end of gnathopod 2, ×177. Female: *f*, Left antenna 1, side view, × 45; *g*, left antenna 1 from above, × 45; *h*, left antenna 2, inside view, × 45; *i*, urosome and uropods, × 90.

Taxonomic remarks.—Following Crawford (1937), in his division of the genus *Corophium* into three sections, we find that the Indian species *C. triaenonyx* Stebbing, with segmented urosome, belongs to section A, while the other one, *C. crassicorne* Brazelius, with unsegmented urosome, belongs to section B. In possessing separate urosome segments the present form clearly belongs to section A. In this feature, as well as in the peraeopods, *C. madrasensis* resembles *C. triaenonyx* a great deal, but it differs from *C. triaenonyx* in not having six plumose setae fringed on the apex of side plates of the first peraeon segment; also in having only four spines in a row on the lower edge on the fourth segment of antenna 2 of the female; and in the possession of a proximal tooth on the inner surface of the fourth joint of the second gnathopod of the male. Besides *C. triaenonyx*, there are 18 species that Crawford (1937) has included under section A, and four others established subsequently. Of these 22 species, 12—*C. volutator* (Pallas), *C. arenarium* Crawford, *C. salmonis*, *C. spinicorne* Stimpson, *C. maeoticum* Sowinski, *C. nobile*, *C. chelicorne*, *C. spinulosum*, *C. robustum*, *C. mucronatum*, *C. curvispinum*, and *C. monodon* G. O. Sars— show no differentiation in segment four of antenna 2 in either sex, thus differing from the species here described. *C. aculeaturm* Chevreux, *C. annulatum* Chevreux, *C. runcicorne* Della Valle, and *C. affine* Bruzelius are extremely small, being only 0.5 to 1.5 mm in length, whereas *C. madrasensis* is definitely of larger build (4 to 4.5 mm). *C. setosum* Shoemaker is not only small (2 mm) but differs also in antenna 1 being as long as antenna 2. In *C. stimpsoni* Shoemaker and *C. brevis* Shoemaker the seventh joint of the gnathopod 2 has five or six teeth on the inner edge, while in *C. madrasensis* there are only three teeth on the inner edge of the seventh joint of the gnathopod 2. The flagellum of the first antenna in the male of *C. madrasensis* is composed of 12 joints, whereas in the male of *C. panamense* Shoemaker it is composed of 17 joints. *C. rioplatense* Giambiagi is a nonborrowing form distinct from *C. madrasensis*.

My thanks are due to Dr. C. P. Gnanamuthu, director, University Zoology Laboratory, Madras, for guidance, and to Clarence R. Shoemaker, associate in zoology, United States National Museum, Washington, for having gone through the paper and offering several valuable suggestions and criticisms and for helping me obtain some of his reprints not available in India.

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ICHTHYOLOGY.—*The comparative food habits of the cyprinid fishes* Nocomis biguttatus *and* Nocomis micropogon *in western New York.*[1]

Ernest A. Lachner, U. S. National Museum.

The comparative food habits of closely related Cyprinidae have received little study. The diet of our nongame fishes has generally been neglected, although it is an important factor in the maintenance of a large forage population. This study compares the food habits of the river chub, *Nocomis micropogon* (Cope), and the hornyhead chub, *Nocomis biguttatus* (Kirtland), during four months of late spring and summer. The type, quantity, and differences in food taken between these species in their various age groups and within the growing season are considered.

Cope (1869, p. 353) related the food of various species of cyprinids with the length of the alimentary canal. He listed the food of *Hypsilepis kentuckiensis* (*Nocomis biguttatus* or *N. micropogon*) as insects and crustaceans, along with other cyprinids, as *Exoglossum maxillingua* (LeSueur) and *Ericymba buccata* Cope, which have short alimentary canals, seven-ninths of standard length.

Forbes (1883, p. 76) placed *Nocomis biguttatus* in a group of Cyprinidae having short intestines and hooked pharyngeal teeth without grinding surfaces, and listed *Phenacobius*, *Semotilus*, *Ericymba*, *Rhinichthys*, and other genera with it. The food habits of 13 *Ceratichthys biguttatus* (*Nocomis* sp.), based upon an examination of the alimentary canals, are listed and compared with 14 other species of Cyprinidae (1883, p. 94). He found the diet to consist of one-fourth insects, "largely case-worms and other neuropterous larvae, another fourth being crustaceans (crawfishes), eaten, however, by only two of the specimens." The remainder of 54 percent (ratio in which the item was found) "was equally divided between algae and seeds of *Setaria* and other grass-like plants." He concludes: "The extraordinary amount of vegetation in the food of this fish is possibly related to the increased length of the alimentary canal," the measurements of which he gave as "the head and body being contained in the intestine about $1\frac{1}{4}$ times."

Evermann and Clark (1920, p. 363) record the diet of *Hybopsis kentuckiensis* (*Nocomis* sp.) to consist chiefly of worms, insect larvae, small crustaceans, and small fishes. Forbes and Richardson (1920, p. 169) have cited the same data as presented by Forbes (1883, p. 94). Although Breder and Crawford (1922) did not study the species concerned here, an interesting summary is presented on the food of related cyprinids. Greeley (1927, p. 60) found the fragments of 10 small clams (*Sphaerium*?) in *Nocomis biguttatus*. Hubbs and Cooper (1936, p. 50) list the larval stages of aquatic insects as the most important item of diet and smaller crustaceans, such as water-fleas, earthworms, and terrestrial insects, as probably eaten to some extent by *Nocomis biguttatus*. They cite that larger *biguttatus* eat some crayfish and that algae and other plants are taken but serve little value as food.

MATERIAL AND METHODS

The stomach contents of 607 specimens of *micropogon* and *biguttatus* were analyzed, 470 containing food. These specimens ranged in age from young of the year to 3-year-old adults and were collected in Sandy Creek, Lake Ontario drainage, Monroe County, N. Y. The dates of the collections, the number of specimens of the two species taken together, the number of stomachs examined in each age group, and the number containing food are given in Table 1.

Only the contents of the stomach were analyzed. These were removed and placed in a watch glass. The organisms were sorted, identified, and counted, and the volume of each was estimated. Only rarely were organisms found in the esophagus or mouth; these were included with the stomach contents. Although food was present in the intestinal tract while the stomach may have been empty, no attempt was made to identify this food other than for general information. Each specimen was aged by scale analysis which was recorded with the individual food description. The high correlation between age and size made it as reliable to compare the diet with age groups as with size groups, and was more convenient in tabulating the

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[1] Received March 15, 1950.

Table 1.—Data Concerning the Collections Used in the Food Analysis of Two Species of Nocomis from Sandy Creek, Monroe County, N. Y.

Date	Age in years	Number caught		Stomachs examined		Stomachs with food		Stomachs with food, in percent	
		1*	2*	1	2	1	2	1	2
July 19, 1939	0+	40	9	40	9	18	6	45.0	66.7
September 25, 1939	0+	39	118	38	118	31	94	81.5	79.5
June 10, 1940	1+	55	73	53	48	38	36	71.7	75.0
July 19 and August 5, 1939	1+	86	79	86	55	22	21	25.6	38.2
September 25, 1939	1+	58	41	58	41	43	28	74.2	68.3
July 19, August 5, and September 25, 1939 and June 10, 1940	2+ or older	24	40	24	37	9	24	37.5	64.9
Total	0+ to 2+	302	360	299	308	161	209	53.9	67.8

* Column 1 = *biguttatus;* Column 2 = *micropogon.*

data. A study of growth of the chubs will be published separately.

HABITAT DESCRIPTION

The area of Sandy Creek from which specimens were taken was approximately 1 to 10 miles above the mouth. The water is normally clear and white, with a normal flow of 50 to 100 cubic feet per second, and a slow to moderate current. The stream varies in width from 50 to 150 feet, through open grazing lands, partial willow growths, or heavier woodlands. The bottom composition is chiefly sandstone bedrock, and low gradient riffles of gravel and rubble are located about every 100 to 150 yards. Some pools are present up to 3 feet in depth, generally below the riffles. Water tempertures vary from 70° to 80° F. during the summer months. Probably the most characteristic feature of this stream is the dense growth, especially early in summer, of filamentous algae, chiefly *Cladophora*. It forms dense mats over the areas of quiet waters, and large strands are present in the riffles. Several species of *Potamogeton* are also present. The stream is smaller with less flow, and contains far more vegetation than is generally reported for a *micropogon* habitat (Hubbs, 1926, p. 29; Hubbs and Cooper, 1936, p. 26). Here *micropogon*, *biguttatus*, and *Notropis cornutus chrysocephalus* (Rafinesque) represent the most abundant species of fish fauna. All three were taken in about equal numbers by seining.

Throughout its range, it appears that *micropogon* is generally distributed in larger streams than is *biguttatus*. This is particularly true of their occurrence in the Allegheny River of western Pennsylvania. The young of *biguttatus* are commonly taken in algal and vascular-plant beds of more slowly flowing water, while the young of *micropogon* generally avoid such a habitat, appearing in the open and faster flowing water.

TYPE OF FOOD TAKEN

Eight orders of Insecta were represented in the diet of *biguttatus*, and ten orders in *micropogon*. Of the orders listed in Table 2, only the Homoptera, Lepidoptera, and Hymenoptera were terrestrial in origin. All other organisms were aquatic with the exception of several Carabidae among the Coleoptera. The following organisms were more specifically identified: The Neuroptera were represented by the family Sialidae, *Corydalis cornuta*, or dobson-fly larvae. Only one *Hexagenia* nymph (Ephemeridae) was found among the Ephemeroptera, all of the others being nonburrowing mayflies, mainly Baetidae. The Anisoptera, dragonflies, were the only Odonata found. The Plecoptera, stoneflies, were chiefly Perlidae. Of the Coleoptera, Hydrophilidae, Haliplidae (*Peltodytes cornuta*), Parnidae (*Psephenus*, the water penny), and a few ground beetles, Carabidae, were recorded. The caddis-worm, *Helicopsyche*, was the most numerous Trichoptera, and *Glossosoma*, *Molanna*, and *Brachycentrus* occurred in smaller numbers. Among the dipterous insects *Simulium*, black-fly larvae, and *Chironomus*, midge larvae, were abundantly found, with but a few other larvae such as *Limnophora* (Anthomyiidae). The dipterous pupae were mostly *Chironomus*.

In the invertebrates, other than insects, only a few water-mites, or hydrachnids, and water spiders were taken. The Crustacea were chiefly Cladocera (water-fleas), Ostracoda, Amphipoda (scuds), Isopoda (sowbugs), and Decapoda (*Cambarus propinquus*, crayfish). The Mollusca were mainly gastropods. *Physa heterostropha* was most commonly identified. *Sphaerium* and *Ferrissa* were also determined. Only one earthworm, *Lumbricus*, was found. Among the animal remains were fish tissue and scales and other undeterminable tissue. The organisms of the stomachs were generally in such a dismembered condition that many were identified to orders only. The plant material was mainly a filamentous algae, *Cladophora*, but small quantities of other filamentous types occurred. Seeds, stems, and leaves of vascular plants were found, and of these, *Anacharis* (water-weed), *Vallisneria*, and *Potamogeton* (pond-weed) were determined.

Table 2.—Summary of Food of Two Species of Nocomis Collected July 19, August 5, September 25, 1939, and June 10, 1940, from Sandy Creek, N. Y.*

	biguttatus				*micropogon*			
Stomachs examined	299				308			
Stomachs with food	161				209			
Item	A†	B	C	D	A	B	C	D
Insecta	—	—	—	59.7	—	—	—	70.6
Neuroptera	—	—	—	—	2	1.0	1.0	0.2
Ephemeroptera	13	1.2	8.1	4.5	34	2.1	16.2	6.1
Odonata	1	1.0	0.6	0.4	—	—	—	—
Plecoptera	1	1.0	0.6	†	6	1.8	2.9	0.3
Hemiptera	5	1.2	3.1	0.5	5	1.4	2.4	1.2
Homoptera	—	—	—	—	1	1.0	0.5	‡
Coleoptera	—	—	—	2.3	—	—	—	4.4
Larvae	6	1.3	3.7	1.2	7	1.0	3.4	2.4
Adults	3	1.0	1.9	1.1	10	1.1	4.8	2.0
Trichoptera	—	—	—	32.4	—	—	—	26.3
Helicopsyche	51	11.0	31.7	25.5	39	6.2	18.6	17.2
Other Trichoptera	20	2.2	12.4	6.9	33	1.3	15.8	9.1
Lepidoptera	—	—	—	—	1	1.0	0.5	‡
Diptera	—	—	—	14.4	—	—	—	25.2
Chironomus larvae	41	9.4	25.4	10.0	42	5.0	20.1	7.6
Simulium larvae	8	4.5	5.0	2.2	36	13.4	17.2	10.0
Other larvae	5	1.8	3.1	1.9	7	1.4	3.4	6.2
Pupae	3	2.0	1.9	†	12	1.8	5.7	0.8
Adults	4	1.0	2.5	0.3	7	1.0	3.4	0.6
Hymenoptera	1	1.0	0.6	†	2	1.0	1.0	0.6
Insecta remains	35	—	21.8	5.2	52	—	24.8	6.3
Arachnida	1	1.0	0.6	‡	4	1.3	1.9	0.5
Crustacea	—	—	—	12.7	—	—	—	4.9
Cladocera	3	21.7	1.9	1.0	—	—	—	—
Ostracoda	14	9.2	8.7	4.0	2	6.5	1.0	0.5
Isopoda	1	1.0	0.6	‡	—	—	—	—
Amphipoda	2	1.0	1.2	1.1	—	—	—	—
Decapoda (*Cambarus*)	17	1.0	1.1	6.5	14	1.0	6.7	4.4
Crustacea remains	2	—	1.2	0.1	—	—	—	
Mollusca	—	—	—	6.7	—	—	—	4.2
Gastropoda	18	1.4	1.1	4.5	11	1.8	5.3	3.9
Pelecypoda	6	1.7	3.7	2.2	2	2.0	1.0	0.3
Annelida	1	1.0	2.6	2.4	—	—	—	
Animal remains	6	—	3.7	1.1	7	—	3.4	0.6
Plants	—	—	—	19.9	—	—	—	19.8
Filamentous algae	36	—	22.4	15.4	77	—	36.8	18.7
Vascular remains	14	—	8.7	4.5	24	—	11.5	1.1

* Specimens ranged in age from young of year to three-year old adults.

† A = Number of stomachs containing item; B = average number of items per stomach; C = percentage of stomachs containing item; D = percentage of volume of all food.

‡ = trace, less than 0.05.

COMPARATIVE FOOD HABITS

Food of young.—The food for early summer was determined by analysis of 40 specimens of young *biguttatus* taken on July 19, 1939, 18 containing food. Ostracods were present in 66.7 percent of the stomachs and formed 36.1 percent of the total volume of food. Three stomachs contained only ostracods and 35 were counted in one. Ephemeroptera nymphs, *Chironomus* larvae, and Cladocera each formed about 10 percent of the volume of all food. One stomach contained no other food except 25 Cladocera. Three stomachs contained algae, forming 13.8 percent of the volume. Six stomachs of 9 *micropogon* specimens taken had food, and the data are compared with *biguttatus* in Table 3.

The food of young *biguttatus* is compared with that of *micropogon* for late summer in Table 3, based on a collection made on September 25, 1939, in which 38 *biguttatus* were caught, 81.5 percent with food, and 118 *micropogon*, 79.5 percent with food. The mean standard length of the specimens of *micropogon* was 4.4 mm greater than that of *biguttatus*. The insect diet of *biguttatus* formed 89.0 percent of the total volume; that of *micropogon*, 83.2 percent. The main items of diet for *biguttatus* were a caddis-fly larva, *Helicopsyche*, 74.3 percent (column

TABLE 3.—FOOD OF THE YOUNG OF TWO SPECIES OF NOCOMIS FROM SANDY CREEK, N. Y.*

Date	July 19, 1939								September 25, 1939							
Species	*biguttatus*				*micropogon*				*biguttatus*				*micropogon*			
Mean S.L.† in mm	33.1				34.5				55.6				60.0			
Range of S.L. in mm.	27–37				30–38				36–67				43–74			
Stomachs examined	40				9				38				118			
Stomachs with food	18				6				31				94			
Stomachs with food (%)	45.0				66.7				81.5				79.5			
ITEM	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Insecta	—	—	—	31.4	—	—	—	83.3	—	—	—	89.0	—	—	—	83.2
Ephemeroptera	3	1.0	16.7	8.6	2	4.5	33.3	31.6	2	1.0	6.5	1.9	22	2.2	23.4	9.4
Plecoptera	—	—	—	—	—	—	—	—	—	—	—	—	5	2.0	5.3	0.5
Hemiptera	—	—	—	—	—	—	—	—	—	—	—	—	2	1.5	2.1	0.2
Coleoptera	—	—	—	—	—	—	—	—	—	—	—	1.9	—	—	—	4.7
Larvae	—	—	—	—	—	—	—	—	1	1.0	3.2	1.9	4	1.0	4.3	3.8
Adults	—	—	—	—	—	—	—	—	—	—	—	—	3	1.0	3.2	0.9
Trichoptera	1	1.0	5.5	5.9	3	1.0	50.0	35.0	—	—	—	6.1	—	—	—	33.7
Helicopsyche	—	—	—	—	—	—	—	—	23	8.8	74.3	56.9	352	6.3	37.3	26.9
Other Trichoptera	—	—	—	—	—	—	—	—	4	2.3	12.9	4.2	10	1.0	10.6	6.8
Lepidoptera	—	—	—	—	—	—	—	—	—	—	—	—	1	1.0	1.1	‡
Diptera	—	—	—	10.7	—	—	—	—	—	—	—	18.0	—	—	—	23.3
Chironomus larvae	4	3.0	22.2	10.7	—	—	—	—	9	7.5	29.0	11.7	22	5.1	23.4	6.5
Simulium larvae	—	—	—	—	—	—	—	—	4	2.5	12.9	6.1	23	13.4	24.5	14.3
Other larvae	—	—	—	—	—	—	—	—	—	—	—	—	3	2.0	3.2	0.9
Pupae	—	—	—	—	—	—	—	—	1	3.0	3.2	0.2	9	1.9	9.6	1.5
Adults	—	—	—	—	—	—	—	—	—	—	—	—	2	1.0	2.1	0.1
Insecta remains	4	—	22.2	6.2	1	—	16.7	16.7	10	—	32.2	6.1	35	—	37.2	11.4
Arachnida	—	—	—	—	—	—	—	—	—	—	—	—	2	1.5	2.1	‡
Crustacea	—	—	—	45.0	—	—	—	16.7	—	—	—	1.3	—	—	—	‡
Cladocera	3	21.7	16.7	8.6	—	—	—	—	—	—	—	—	—	—	—	—
Ostracoda	12	10.4	66.7	36.1	1	12.0	16.7	16.7	—	—	—	—	1	1.0	1.1	‡
Decapoda (*Cambarus*)	—	—	—	—	—	—	—	—	1	1.0	3.2	1.3	—	—	—	—
Crustacea remains	1	—	5.5	0.3	—	—	—	—	—	—	—	—	—	—	—	—
Mollusca	—	—	—	13.8	—	—	—	—	—	—	—	6.9	—	—	—	5.6
Gastropoda	4	1.0	22.2	13.8	—	—	—	—	6	1.3	19.4	5.6	4	2.3	4.3	4.8
Pelecypoda	—	—	—	—	—	—	—	—	1	1.0	3.2	1.3	2	2.0	2.1	0.8
Plants	—	—	—	9.8	—	—	—	—	—	—	—	2.8	—	—	—	11.0
Filamentous algae	3	—	16.7	9.8	—	—	—	—	6	—	19.4	2.8	29	—	30.1	10.5
Vascular remains	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1.1	0.5

* For explanation of A, B, C, and D, see footnote to Table 2.

† S.L. = standard length.

‡ See footnote to Table 2.

Table 4.—Food of the Juveniles (Second Summer) of Two Species of Nocomis from Sandy Creek, N. Y.

Date	June 10, 1940								July 19 and August 5, 1939								September 25, 1939							
Species	*biguttatus*				*micropogon*				*biguttatus*				*micropogon*				*biguttatus*				*micropogon*			
Mean S.L. in mm.	53.5				73.9				86.7				92.0				87.2				98.1			
Range of S.L. in mm.	38–76				55–91				65–106				79–110				69–109				82–133			
Stomachs examined	53				48				86				55				58				41			
Stomachs with food	38				36				22				21				43				28			
Stomachs with food (%)	71.7				75.0				25.6				38.2				74.2				68.3			
ITEM	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Insecta	—	—	—	71.9	—	—	—	53.2	—	—	—	63.1	—	—	—	65.4	—	—	—	47.9	—	—	—	26.3
Ephemeroptera	4	1.8	10.5	4.6	6	1.5	16.7	2.5	4	1.0	18.2	15.1	2	2.0	9.5	3.9	—	—	—	—	1	1.0	3.6	1.1
Odonata	1	1.0	2.6	1.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Plecoptera	—	—	—	—	1	1.0	2.7	0.4	—	—	—	—	—	—	—	—	1	1.0	2.3	†	—	—	—	—
Hemiptera	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	1.2	11.6	2.0	2	1.5	7.2	2.9
Coleoptera	—	—	—	4.7	—	—	—	2.4	—	—	—	0.3	—	—	—	4.8	—	—	—	0.7	—	—	—	—
Larvae	1	1.0	2.6	0.4	1	1.0	2.7	1.0	—	—	—	—	—	—	—	—	2	1.5	4.7	0.7	—	—	—	—
Adults	2	1.0	5.3	4.3	2	1.5	5.6	1.4	1	1.0	4.6	0.3	1	1.0	4.8	4.8	—	—	—	—	—	—	—	—
Trichoptera	—	—	—	8.2	—	—	—	6.3	—	—	—	47.3	—	—	—	40.7	—	—	—	42.8	—	—	—	4.3
Helicopsyche	—	—	—	—	1	1.0	2.7	0.8	7	3.9	31.8	27.2	2	2.0	9.5	9.3	20	16.2	46.6	40.1	—	—	—	—
Other Trichoptera	6	2.2	15.8	8.2	5	1.2	13.9	5.5	5	2.2	22.7	20.1	8	2.6	38.1	31.4	3	1.0	7.0	2.7	5	1.4	17.9	4.3
Diptera	—	—	—	38.5	—	—	—	32.1	—	—	—	0.2	—	—	—	7.8	—	—	—	1.1	—	—	—	12.0
Chironomus larvae	21	13.6	55.2	25.4	12	7.1	33.3	11.4	2	1.5	9.1	0.2	2	2.5	9.5	1.9	5	3.6	11.6	0.4	5	1.4	17.9	6.3
Simulium larvae	3	8.3	7.9	4.3	11	13.9	30.6	18.2	—	—	—	—	2	11.0	9.5	4.5	1	1.0	2.3	0.2	—	—	—	
Other larvae	4	2.0	10.5	8.0	1	1.0	2.7	1.1	1	1.0	4.6	†	—	—	—	—	—	—	—	—	2	1.0	7.2	3.6
Pupae	1	1.0	2.6	†	3	1.7	8.3	0.7	—	—	—	—	—	—	—	—	1	2.0	2.3	†	—	—	—	—
Adults	2	1.0	5.3	0.8	2	1.0	5.6	0.7	—	—	—	—	1	1.0	4.8	1.4	2	1.0	4.7	0.5	2	1.0	7.2	2.1
Hymenoptera	—	—	—	—	1	1.0	2.7	0.7	—	—	—	—	—	—	—	—	1	1.0	2.3	0.2	1	1.0	3.6	3.6
Insect remains	15	—	39.4	14.1	10	—	27.8	8.8	1	—	4.5	0.2	2	—	9.5	8.2	5	—	11.6	1.1	4	—	14.3	2.6
Arachnida	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1.0	2.3	†	2	1.0	7.2	3.6
Crustacea	—	—	—	9.9	—	—	—	5.3	—	—	—	22.4	—	—	—	14.3	—	—	—	11.3	—	—	—	3.5
Ostracoda	2	1.5	5.3	†	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Isopoda	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—	1	1.0	2.3	†	—	—	—	—
Amphipoda	2	1.0	5.3	5.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Decapoda (*Cambarus*)	2	1.0	5.3	4.7	3	1.0	8.3	5.3	6	1.0	27.2	22.0	3	1.0	14.3	14.3	5	1.0	11.6	11.3	1	1.0	3.6	3.5
Crustacea remains	—	—	—	—	—	—	—	—	1	—	4.6	0.4	—	—	—	—	—	—	—	—	—	—	—	—
Mollusca	—	—	—	2.4	—	—	—	—	—	—	—	9.6	—	—	—	0.6	—	—	—	7.5	—	—	—	3.9
Gastropoda	—	—	—	—	—	—	—	—	3	1.0	13.6	9.4	1	1.0	4.8	0.6	5	2.2	11.6	2.3	2	1.0	7.2	3.9
Pelecypoda	1	1.0	2.6	2.4	—	—	—	—	1	2.0	4.6	0.2	—	—	—	—	3	2.0	7.0	5.2	—	—	—	—
Annelida	1	1.0	2.6	2.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Animal remains	3	—	7.9	5.3	—	—	—	—	1	—	4.6	0.2	—	—	—	—	2	—	4.7	†	6	—	21.4	5.8
Plants	—	—	—	8.5	—	—	—	41.2	—	—	—	4.6	—	—	—	19.4	—	—	—	33.3	—	—	—	56.8
Filamentous algae	3	—	7.9	0.3	10	—	27.8	12.2	4	—	18.2	4.6	6	—	28.6	19.4	19	—	44.2	29.1	21	—	75.0	56.8
Vascular remains	6	—	15.8	8.2	17	—	47.2	29.0		—	—	—	—				4	—	9.3	4.2	—	—	—	—

C, percentage of stomachs containing the item, Table 3); midge larvae, *Chironomus*, 29.0; black-fly larvae, *Simulium*, 12.9; mayflies, Ephemeroptera, 6.5; snails, Gastropoda, 19.4; and filamentous algae, 19.4. Comparable data for *micropogon* were *Helicopsyche*, 37.3; *Chironomus*, 23.4; *Simulium*, 24.5; Ephemeroptera, 23.4; Gastropoda, 4.3; and filamentous algae, 30.1. Considering the other items listed, Table 3, one can only note minor differences in the food habits of the young collected in September. It is interesting that *micropogon* had eaten considerably more algae (see D, Table 3) than had *biguttatus*, probably not to be expected if one considered the habitat preferences of the two species.

In September ten stomachs of young *micropogon* contained only *Helicopsyche*, of which 37 larvae and the snaillike cases appeared in a single stomach; this type averaged 6.3 per stomach when present. *Simulium* and *Chironomus* also frequently formed a single item of diet for an individual *micropogon* or *biguttatus*; 96 of the former were counted in one *micropogon* stomach and 36 of the latter in a single stomach of *biguttatus*. Six *micropogon* stomachs contained algae exclusively.

Food of juveniles, in second summer's growth; for late spring.—The food of juvenile *Nocomis* for late spring was based on the analysis of 53 *biguttatus*, 71.7 percent with food, and 48 *micropogon*, 75 percent containing food, collected June 10, 1940. The data are summarized in Table 4. The mean standard length of the *micropogon* sample exceeded that of *biguttatus* by 20.4 mm. The insect diet of *biguttatus* represented 71.9 percent of the total volume of all food taken, compared to 53.2 in *micropogon*. The common items of food for both species were Ephemeroptera, 10.5, 16.7 (percentage of stomachs containing item in *biguttatus* and *micropogon* respectively); Trichoptera larvae, 15.8, 16.6; *Chironomus* larvae, 55.2, 33.4; *Simulium* larvae, 7.9, 30.6; and *Cambarus*, 5.3, 8.3.

A similar difference occurs with the plant material taken, as mentioned above for the young during September. In *biguttatus* only small amounts of filamentous algae were found, 7.9 percent of the stomachs containing algae, forming 0.3 percent of total volume of all food, compared to 27.8 and 12.2 percent for *micropogon*. The vascular plant remains showed the same trend: in *biguttatus*, 15.8, 8.2; *micropogon*, 47.2, 29.0.

Chironomids were taken in considerable numbers by *biguttatus*, 286 appearing in 21 stomachs, averaging 13.6 per stomach. As many as 78 were counted in a single specimen. Other comparative data concerning food items eaten are presented in Table 4.

Food of juveniles in midsummer.—Food studies of juvenile *Nocomis* for midsummer were based on 86 *biguttatus*, 25.6 percent with food and 55 *micropogon*, 38.2 percent containing food, collected July 19 and August 5, 1939. The data are summarized in Table 4. The high percentage of empty stomach is of interest and may be related to the observed "schooling" habits of both species during midsummer in Sandy Creek. The specimens of these two collections were taken only in several seining hauls through the pools, up to 3 feet in depth, below low gradient riffles. The chubs were easily observed for the school was compact. This habit is somewhat contrary to the general reports of others and was not observed during June and September in Sandy Creek. In June they are generally distributed in riffles, shallow pools and also about the heavy algal growth of the more slowly flowing water. They usually caught in small numbers, four or five appearing in a good seine haul. In September their habits are more secretive and solitary, especially the larger adults. One or two may be taken from under a slab rock, and numbers are caught only by much seining.

There was little difference in the insect diet of the two species. In *biguttatus* it was 63.1 percent of the total volume; and in *micropogon*, 65.4. Ephemeroptera nymphs and *Helicopsyche* and other trichopterous larvae were the common forms. A notable reduction of *Chironomus* and *Simulium* as food items was noted, their sum being 0.2 in *biguttatus* and 6.4 in *micropogon*, in percent of volume of all food. Many more crayfish, *Cambarus*, appeared than in the younger specimens of June. In *biguttatus*, crayfish were found in 27.2 percent of the stomachs totaling 22 percent of the food by volume, and in *micropogon* similar figures were 14.3 and 14.3 percent. Filamentous algae were again consumed in greater amounts by *micropogon*. It was present in 18.2 percent of the stomachs of *biguttatus* and 28.6 in *micropogon*, forming 4.6 percent of the food volume in the former and 19.4 in the latter. Those stomachs with food contained smaller amounts, and the average number of items per stomach (Table 4, column B) was lower.

Food of juveniles late in summer.—A summary of the food of juvenile *Nocomis* for late summer is also presented in Table 4. A reduction of insect food was noted in both species, insects constituting 47.9 percent of food volume in *biguttatus* and 26.3 percent in *micropogon*. Greater amounts of filamentous algae were taken, such algae appearing in 44.2 percent of stomachs in *biguttatus* (29.1 percent of volume), and in 75 percent of stomachs of *micropogon* (56.8 percent of volume). *N. biguttatus* had eaten many *Helicopsyche*, this food item appearing in 46.6 percent of stomachs, and representing 40.1 percent of the volume of all food. Twenty stomachs averaged 16.2 of these caddisfly larvae, and as many as 68 were counted in one individual. No *Helicopsyche* were included in the diet of *micropogon*.

Food of adults, two years old or more.—The summer food of the larger and older specimens is presented in Table 5. The classification "adult" is for convenience in terminology. Some of the "juveniles" of September (Table 4) were mature fish. Chubs more than 2 years old formed but a small part of the total population sampled, representing 8 percent of 302 *biguttatus* and 11 percent of 360 *micropogon* specimens. Fewer insects were eaten by this group. *N. biguttatus* had 12.2 percent of the volume of all food composed of insects and *micropogon* 32.5 percent. No order of insects predominated. *Cambarus* was more commonly eaten appearing in 33.3 percent of the stomachs of *biguttatus* and 29.2 percent in *micropogon*. Plant material composed a large part of the volume of all food, forming 55.6 percent in *biguttatus* and 44.1 in *micropogon*.

The vegetable matter ranked second only to insects in volume of all food taken for all age groups. It was probably taken secondarily, through the acquisition of animal food. The intestinal tract usually contained undigested filamentous algae. The raptorial dentition of both species does not suggest a vegetable diet, nor does the short length of the intestines, which is probably similar in both species (for five adults, length of distended intestine into standard length: *biguttatus*, range 1.2–1.4, average 1.3; *micropogon*, range 1.0–1.4, average 1.2).

Table 5.—Food of the Adults (2 Years old or More) of Two Species of Nocomis Collected July 19, August 5, September 25, 1939, and June 10, 1940, from Sandy Creek, N. Y.

	biguttatus				*micropogon*			
Mean S.L. in mm	99.8				122.6			
Range of S.L. in mm	88–118				93–150			
Stomachs examined	24				37			
Stomachs with food	9				24			
Stomachs with food (per cent)	37.5				64.9			
Item	A	B	C	D	A	B	C	D
Insecta	—	—	—	12.2	—	—	—	32.5
Neuroptera	—	—	—	—	2	1.0	8.3	4.6
Ephemeroptera	—	—	-	—	1	1.0	4.2	0.2
Hemiptera	—	—		—	1	1.0	4.2	4.2
Homoptera	-		—	—	1	1.0	4.2	0.2
Coleoptera	—	—	—	8.9	—	—	—	11.9
Larvae	1	2.0	11.1	8.9	2	1.0	8.3	4.3
Adults	—	—	—	—	4	1.0	16.7	7.6
Trichoptera	-	—	—	3.3	—	—	—	7.1
Helicopsyche	1	10.0	11.1	2.2	1	17.0	4.2	4.0
Other Trichoptera	1	6.0	11.1	1.1	2	2.5	8.3	3.1
Diptera	—	—	—	—	—	—	-	4.3
Chironomus larvae	—	—	—	—	1	2.0	4.2	0.1
Other larvae	—	—	—	—	1	1.0	4.2	4.2
Crustacea								
Decapoda (*Cambarus*)	3	1.0	33.3	32.2	7	1.0	19.2	13.5
Mollusca								
Gastropoda	—	—	—	—	4	2.0	16.7	9.4
Animal remains	—	—	—	—		—	4.2	0.8
Plants	—	—	—	55.6	—	—	—	44.1
Filamentous algae	1	—	11.1	11.1	11	-	45.8	33.8
Vascular remains	4	—	44.5	44.5	6	-	25.0	10.3

This is in agreement with Breder and Crawford (1922) and contrary to Forbes (1883 p. 89). A general summary of the numbers of individual food items consumed for all age groups of both species is presented in Table 2.

SUMMARY

1. The study of food habits was based on stomach examination of 607 specimens (470 with food) of *Nocomis micropogon* and *N. biguttatus*, that ranged in age from young to 3-year-old adults, and ranged in size from 27 to 150 mm in standard length.

2. Practically all the animal food for both species was composed of aquatic Insecta, Crustacea, and Mollusca.

3. The types of food taken by the two species were very similar. The organisms most frequently encountered in the stomachs were *Simulium*, *Chironomus*, *Helicopsyche*, various Ephemeroptera, and *Cambarus*. Ostracoda and Cladocera were eaten in appreciable numbers only by the young of the year during July.

4. Only minor differences existed in the comparative amounts of animal food taken by each species.

5. Filamentous algae, chiefly *Cladophora*, and vascular plants were taken in large quantities. It is probable that much of the plant material was taken with the animal food.

6. Almost all food was benthotic, other than the Ostracoda and Cladocera food of the young.

7. More stomachs were found empty during the midsummer months of July and August compared to those collected in June and September. Stomachs containing food at midsummer had less food by numbers or volume, compared with stomachs examined for June or September. This reduced feeding may be related to a schooling habit which was observed; perhaps food was not available to all *Nocomis* in the compact school.

8. Aquatic insects provided most of the food for the young and smaller juveniles of both species. Crayfish were eaten in greatest quantities by the larger and older juvenile and adult chubs. Plant material, chiefly filamentous algae, formed almost one-half of the volume of the stomach contents of the older juveniles and adults.

This study represented a part of the thesis requirements for the degree of doctor of philosophy, Cornell University. The writer is indebted to Dr. Edward C. Raney, Cornell University, for aid and useful suggestions in the preparation of this work.

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ORNITHOLOGY.—*The northern races of Dendrocolaptes certhia.*[1] W. E. Clyde Todd, Carnegie Museum, Pittsburgh. (Communicated by H. G. Deignan.)

The woodhewer *Dendrocolaptes certhia* (Boddaert) has a wide distribution in tropical America, from Brazil and Bolivia north through Central America to southeastern Mexico. It is a plastic species and divides up into a number of well-marked geographical races. The South American forms were treated by Hellmayr (Publ. Field Mus. Nat. Hist., zool. ser., **13**(4): 259–264. 1925), and later by Zimmer. (Amer. Mus. Nov. no. 753: 1–4. 1934), but so far as I am aware no recent taxonomic work has been done on the northern races, which seem to be in need of further revision. Four forms can be recog-

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[1] Received May 8, 1950.

nized with the material at hand, all of which is in the Carnegie Museum Collection.

Dendrocolaptes certhia sancti-thomae (Lafresnaye)

Dendrocops sancti-thomae Lafresnaye, Rev. et Mag. Zool. (2) **4**: 466. 1852 ("in insula Sancti-Thomae" [error];—Santo Tomás, Guatemala).

Ten specimens: Manatee Lagoon, Quamin Creek, Toledo District, El Cayo, Cockscomb Mountains, and Freetown, British Honduras; La Ceiba, Honduras.

Measurements.—Five males: Wing, 120–127 (average, 123); tail, 107–113 (110); exposed culmen, 36–38 (37) mm.

Range.—From Veracruz and Campeche south through Guatemala, British Honduras, and Honduras (to Nicaragua?).

Remarks.—In this race the pileum is more decidedly rufescent, and thus more strongly contrasted with the rest of the underparts, than in Costa Rican and Colombian birds. The type locality was erroneously given as the island of St. Thomas, in the Lesser Antilles, but is actually Santo Tomás, "Honduras" (now across the line in Guatemala), as pointed out by Salvin and Godman (Biol. Centr.-Amer., Aves, **2**: 192, 1892). Inasmuch as our single specimen from La Ceiba is like British Honduras birds, all may safely be regarded as being typical of this race. I have not seen any specimens from Mexico or Nicaragua. There is little difference in general size between Costa Rican and British Honduras examples, but in the latter the bill is more extensively pale at the base below. This and the more rufescent pileum are good racial characters.

Dendrocolaptes certhia nigrirostris, subsp. nov.

Fourteen specimens: Guapiles, Guacimo, Cuabre, El Hogar, Bebedero, and Miravalles, Costa Rica.

Type.—Carnegie Mus. no. 26812, adult male; El Hogar, Costa Rica, December 30, 1905; M. A. Carriker, Jr.

Subspecific characters.—Similar to *Dendrocolaptes certhia sancti-thomae* (Lafresnaye) of southeastern Mexico, Guatemala, and Honduras, but general tone of coloration darker (more brownish), and bill shorter, and black or nearly so, with the pale area in the mandible much reduced or wanting.

Measurements.—Nine males: wing, 119–134 (average, 129); tail, 111–121 (117.5); exposed culmen, 35–40 (33) mm.

Remarks.—The shorter and differently colored bill is the best character of this race. In our series of 14 specimens the bill is given as "black" by the collector, or "black with pale edge." Comparison in series brings out the slightly darker coloration also, although some individual specimens would be indistinguishable on this score. The size is about the same. Fall and winter birds average slightly paler than summer breeding specimens. A single immature bird (no. 27306, June 18) is indistinguishable from adults except by its slightly shorter bill and less distinctly barred lower abdomen and under tail coverts.

Dendrocolaptes certhia hesperius Bangs

Dendrocolaptes sancti-thomae hesperius Bangs, Auk **24**: 299. 1907 (Lagarto, Costa Rica).

Two specimens: El Pozo de Terraba, Costa Rica.

These bear out the main character ascribed to this form: the narrower barring of the underparts. Its known range is confined, however, to the Terraba Valley in southwestern Costa Rica, since birds from the other parts of the country are appreciably different. In their generally duller coloration and dark-colored bills our two birds resemble Colombian specimens but differ therefrom in their narrow barring below. This race probably ranges into western Panama.

Dendrocolaptes certhia colombianus, subsp. nov.

Fourteen specimens: Jaraquiel, El Tambor, Murindo, Quibdó, Andagoya, Potedo, and Malagita, Colombia.

Type.—Collection Carnegie Mus. no. 624293, adult male; Murindo, Colombia, February 16, 1918; M. A. Carriker, Jr.

Subspecific characters.—Similar to *Dendrocolaptes certhia nigrirostris* mihi of Costa Rica, etc., but general coloration of pileum and underparts more buffy, less rufescent, and bill longer and paler (more brownish) at base below.

Measurements.—Ten males: Wing, 125–134 (average, 129); tail, 108–127 (115); exposed culmen, 36.5–42 (38.5) mm.

Range.—Northern and western Colombia, west of the Magdalena Valley, and south to Ecuador.

Remarks.—As a series these average a little paler below than Costa Rican birds; the ground color is buffy rather than rufescent. The pileum also is noticeably buffier. The mandible is marked by the collector as "pale horn-color at base", but it is not so extensively pale as in typical *sancti-thomae*. The color characters, in connection with the relatively longer bill, serve to make this an easily recognizable race when compared with *nigrirostris*.

The El Tambor specimen, however, from the interior of Colombia, may represent another race of this species.

HERPETOLOGY.—*A new subspecies of toad from Santa Catharina, Brazil.*[1] DORIS M. COCHRAN, U. S. National Museum.

During a study of the giant toads of Brazil, I compared a series of 91 *Bufo icterícus* Spix from Rio de Janeiro and São Paulo with 75 somewhat similar toads from Santa Catharina and found the latter deserving of subspecific recognition. I take pleasure in naming the new form after Dr. Robert Mertens, whose interest in the amphibians of southern Brazil is of long standing.

Bufo ictericus mertensi, n. subsp.

Diagnosis of Bufo ictericus mertensi.—Resembles *Bufo ictericus* Spix in general structure and color. Differs in having a longer femur and tibia and a narrower head than the true *ictericus*.

Description of the type.—An adult male, U.S.N.M. no. 105244 from Nova Teutonia, Itá, Santa Catharina, collected in 1938 by Fritz Plaumann. Tongue broadly elliptical, nearly one-half as wide as mouth opening, entire and free for its posterior half; snout short, rounded when seen from above and in profile, the upper jaw not extending beyond the lower; nostrils twice as far from eye as from tip of snout, well below the canthus, their openings superolateral, separated from each other by an interval equal to their distance from eye. Canthus rostralis with a heavy crest, which forks in front of eye, the main crest continuing above eye and forking again to form a short medial parietal crest, and a heavy postorbital crest which connects with the parotoid by a very short bridge; interorbital space concave; parotoid glands large and heavy, obovate, their inner borders slightly concave, their posterior borders on a level with the axillae. Eye moderate, scarcely projecting beyond the surrounding ridges, its diameter a little less than its distance from end of snout; interorbital diameter twice the width of upper eyelid, and twice the distance between nostrils. Tympanum very distinct, higher than broad, its height equal to three-fifths the diameter of eye, separated from eye by less than one-half its own height. Fingers free, with distinct lateral ridges, first finger longer than second and fourth; palmar tubercles prominent; subarticular tubercles of fingers single except for distal ones of third finger, which are double; toes nearly one-half webbed, fringed laterally to the tips, third much longer than fifth and reaching to base of penultimate phalanx of fourth; a small oval inner and a round outer metatarsal tubercle; subarticular tubercles of toes reduced to small spinules almost indistinguishable from those covering the tarsus; a distinct tarsal ridge marked by small tubercles. Body not especially stout, in postaxillary region nearly equal to greatest width of head; when hind leg is adpressed, heel reaches to front of shoulder; when limbs are laid along the sides, knee and elbow touch; when hind legs are bent at right angles to the body, heels fail to meet. Dorsum covered with large and small warts, all of them closely set with small dark spinules (in the male). Scapular ridges very heavy. No large tibial gland. No skin fold on chest. Venter coarsely granular, the throat and chest with small spiny tubercles mixed with the granules.

Color of adult male.—Back olive, with the numerous large warts set off by minute seal-brown spinules; top of crests and parotoid glands russet to clay color. Lower parts buff, the belly and sides with a coarse olive network; a few buff spots on outer sides of parotoid glands. Upper lip with a pale buff area from tip of snout to below eye, the labial crests with many small brown spinules. Palms and soles pale olive; the tips of fingers and toes, as well as the palmar and metatarsal tubercles, dark brown.

The females and young are much more brightly marked with a wide buff middorsal stripe, on each side of which is a row of dark brown spots, the anterior extending onto the eyelids. In older females the brown spots often fuse to a pair of sinuous brown stripes bordering the yellowish

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[1] Received May 8, 1950.

middorsal one. The olive or brown ventral reticulations are more extensive in some specimens, reaching as far forward as the chest. A semicircle of buff on the side of the chest marks the insertion of the arm.

Measurements of the type.—Total length, 102 mm; head length (to posterior border of tympanum), 30.5 mm; head width, 42 mm; femur, 41 mm; tibia, 45 mm; foot (from proximal base of inner metatarsal tubercle), 41.5 mm; hand, 28 mm.

CRITICAL MEASUREMENTS IN PERCENTAGE OF TOTAL LENGTH

	Head length	Head width	Femur	Tibia	Foot	Hand
In the type	29.8	41.2	40.2	44.1	40.7	27.4
In the entire series of 75 specimens:						
Mean	28.9	39.9	41.6	39.2	40.2	25.5
σ	1.77	1.55	2.74	1.87	2.53	1.52
Variation	6.1	3.9	6.6	4.8	6.3	6.0
σ_M	.205	.179	.317	.217	.295	.177
Range	24.0–33.4	35.5–44.0	35.9–48.2	34.8–44.1	33.4–46.0	20.3—29.5

Significant differences in twice the Standard Error of the Mean above and below the Mean are found in three of the critical measurements of *mertensi* as compared to the true *ictericus* from Rio de Janeiro and São Paulo. The head width is greater in *ictericus*, while the length of femur and tibia are greater in *mertensi*.

When a typical specimen of *ictericus* (U.S.N.M. no. 97740 from Nova Friburgo, Rio de Janeiro) is compared with the type of *mertensi*, the following differences are apparent:

Character	*ictericus*	*mertensi*
Tongue	Oval, one-third width of mouth.	Broadly elliptical, nearly one-half.
Nostrils	A little nearer to snout tip than to eye.	Twice as far from eye as from snout tip.
Interval between nostrils	Greater than their distance from eye.	Equal to that distance.
Eye diameter	Greater than its distance from snout tip.	A little less.
Tympanum/eye diameter	One-half	Three-fifths
Subarticular tubercles of fingers	Double (basal) or semidivided (distal).	Single (basal) distal of third double.
Toes webbed	One-third.	Nearly one-half.
Tarsal ridge	Faint, short.	Distinct, marked by tubercles.
Subarticular tubercles of toes	Small, double.	Reduced to small spinules.
Width of body in postaxillary region	1½ times head width.	Nearly equal.
Knee and elbow	Fail to meet.	Touch.
Heels	Touch.	Fail to meet.
Scapular ridges	Very indistinct.	Very heavy.
Skinfold on chest	Slight.	Absent.

As many of these differences tend to merge when large series of both forms are compared, the diagnosis of *mertensi* is based on essential differences in critical measurements.

Paratypes.—U.S.N.M. nos. 103842–103906 and 105245–105251, with the same data as the type; U.S.N.M. nos. 98777–98778 from São Bento, Santa Catharina, collected by Bruno Behr in 1935.

PROCEEDINGS OF THE ACADEMY

438TH MEETING OF BOARD OF MANAGERS

The 438th meeting of the Board of Managers, held in the Cosmos Club on May 15, 1950, was called to order by President F. B. Silsbee at 8:08 p.m. Also present were: H. S. Rappleye, J. A. Stevenson, H. A. Rehder, F. C. Kracek, W. N. Fenton, C. L. Gazin, W. R. Wedel, W. A. Dayton, E. W. Price, H. W. Hemple, H. G. Dorsey, O. B. French, F. M. Setzler, and, by invitation, R. G. Gates and J. L. Shereshefsky.

The President appointed J. A. Stevenson to serve as the Academy's official delegate to the Seventh International Botanical Congress at Stockholm July 12–20, 1950. An invitation was read from the Fifth South American Congress of Chemistry inviting the Academy to participage in its proceedings to be held at Lima, Peru, May 4–11, 1951.

The Chairman of the Committee on Membership submitted the names of 25 nominees for resident membership. Fifteen individuals previously nominated were elected.

A letter from the American Association for the Advancement of Science indicated the amount of money available to the Academy for grants-in-aid of research.

Mrs. Annie M. Karrer was placed on the retired list, as of December 31, 1950.

Two deaths were reported: Oakes Ames, University Museum, Cambridge, Mass., on April 28, 1950 (elected June 8, 1931), and L. O. Howard, former chief of the Bureau of Entomology, on May 1, 1950 (original member; elected to honorary membership February 26, 1930).

The Treasurer reviewed the transaction concerning the purchase of Washington Sanitary

Improvement Co. stock held by the Academy and indicated that more than the necessary shares had been turned in to the Washington Loan & Trust Co. The President indicated that on the basis of rule 4 of the Standing Rules of the Board of Managers the reinvestment of the proceeds from the sale of these shares will be considered by the Executive Committee, which will report its action to the Board.

The meeting adjourned at 8:52 p.m.

F. M. Setzler, *Secretary.*

Obituary

Henri François Pittier, honorary member of the Washington Academy of Sciences, died on January 27, 1950, in Caracas, Venezuela.

Pittier was born at Bex, near the Rhone River, in the Bernese Alps, Switzerland, on August 13, 1857. He was educated in Swiss polytechnical schools and universities, receiving several degrees, including that of civil engineer and D.Sc., and also Ph.D. from Jena. He was in the Swiss Topographical Survey for two years and taught in Swiss universities for five years. In 1887 he went to Costa Rica, where he founded the Observatorio Meteorológico and the Instituto Físico-Geográfico and served as director of the latter. In his 18 years in Costa Rica he made extensive surveys, prepared the first accurate map of the country, and built up a great herbarium in the Instituto. Between 1891 and 1900 he published the *Primitiae florae Costaricensis*, with Th. Durand, J. Donnell-Smith, C. DeCandolle, Lindau, Pax, Engler, H. Christ, and others collaborating. He also published studies in anthropology, ethnography, and linguistics of the Indians of Costa Rica.

From January 1905 to October 1919 he served in the U. S. Department of Agriculture as botanist engaged in agricultural investigations in Central America. In 1910 he was in charge of the botanical survey of Panama under the Smithsonian Institution. While in the Department of Agriculture he explored all the countries of Central America and also Colombia and Venezuela, making extensive botanical collections, and publishing the results, especially on trees and woody plants, in the Contributions from the U. S. National Herbarium.

In 1913 and from March 1914 to March 1915, and again from February 1917 to February 1919, Dr. Pittier took leave without pay to work in Venezuela, and he resigned from the U. S. Department of Agriculture October 14, 1919, to go to Venezuela as director of the Museo Commercial. There, continuing his explorations of Venezuela, he built up a large herbarium. In 1933 he was made director of the National Observatory, and in 1936 was made director of the Servicio Botánico in the Ministry of Agriculture. Here he built up the National Herbarium and a large collection of wood samples of Venezuelan trees.

The Parque Nacional in Aragua and the Sociedad Venezolana de Ciencias Naturales were established through Pittier's influence. It was also through his efforts that a law was passed forbidding the burning of the forests on the mountain slopes, which were fast being destroyed by charcoal burners and others.

Dr. Pittier was recognized in Venezuela as the leading scientist of the country, and his ninetieth birthday, August 13, 1947, was celebrated by the Ministry of Agriculture and the learned societies. The Medal of the Order of the Libertador [Bolívar] and the Order of Francisco de Miranda were bestowed upon him by the Venezuelan Government. Dr. Pittier had interested himself in the higher education of young Venezuelans, and when an ample purse was presented to him on his birthday he designated that it was to form a fund for advanced education for Venezuelan students. He continued his botanical explorations until within a year of his death.

Dr. Pittier was naturalized while in the U. S. Department of Agriculture and maintained his citizenship of this country. He was a member of many learned societies in Europe and America and was an associate in botany in the Smithsonian Institution.

The Parque Nacional at Rancho Grande, Aragua, it is reported, is to be renamed the Henri Pittier International Biological Laboratory.

His bibliography includes over 300 papers on botany, forestry, Indian archeology, ethnography, and linguistics.

His home, surrounded by an extensive garden, with many of the beautiful orchids of Venezuela attached to the trees, was in a suburb of Caracas with a view of the distant mountains. Here he and his gracious wife extended hospitality to many visiting botanists.

Agnes Chase.

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Vol. 40 August 15, 1950 No. 8

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JOURNAL
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VOLUME 40 August 15, 1950 No. 8

BOTANY.—*Studies in the Begoniaceae*, III.[1]

LYMAN B. SMITH, Department of Botany, U. S. National Museum, and BERNICE G. SCHUBERT, Gray Herbarium of Harvard University.

The present miscellany of notes and novelties is written as an addendum to a floristic treatment of the family already made, *The Begoniaceae of Colombia*[2], and as a preface to further floristic papers.

MEXICO

Begonia boissieri A. DC. in Ann. Sci. Nat. IV. **11**: 126. 1859; in DC. Prod. **15**¹: 311. 1864.
FIGURE 1, *a*

Begonia suffruticosa Pav. ex A. DC. in DC. Prod. **15**¹: 311. 1864, nomen in synon.

Type in the Herbier Boissier, collected at an unknown locality in Mexico, presumably by Sessé and Mociño. Macbride photo no. 8517.

GUERRERO: In granitic soil on mountainside beside a swift stream, mixed pine and cacti, 25 miles south of Chilpancingo, August 16, 1947, *Paxson, Webster, & Barkley* 17M806 (GH); in loose granitic cliff 3 miles north of Taxco, August 21, 1947, *Paxson, Westlund, & Barkley* 17M881 (GH); moist shaded bank, juniper- and oak-wooded slopes above and east of Taxco on trail to Chacualco, altitude 1,740–1,860 meters, August 18, 1948, *Moore & Wood* 4615 (GH).

A. De Candolle indicated the origin of *Begonia boissieri* as possibly Mexico and later added Peru. As we have pointed out in connection with *B. monophylla* Pav.,[3] the confusion arises from Pavon's having collected in Peru himself but having acquired collections of Sessé and Mociño from Mexico and leaving them inadequately labeled. The above recent material proves that the species is Mexican.

As noted in the Prodromus, *B. boissieri* is related to *B. falciloba* Liebm. and *B. bulbillifera* Link and Otto. It differs from *B. falciloba* in its shallowly undulate-lobate leaves and from *B. bulbillifera* in having peduncles and in its deciduous brownish stipules.

Begonia hidalgensis Smith & Schubert, sp. nov.
FIGURES 1, *b–g*

Subacaulis; foliis asymmetricis, transverse ellipticis; scapo elato; inflorescentia inaequaliter cymosa, multiflora; tepalis masculinis 2, orbicularibus; staminibus liberis, antheris obovoideis; tepalis femineis 5, ellipticis, acutis; capsula inaequaliter trialata.

Stem short and repent with the scapes and leaves borne at its apex, 1 cm. thick, internodes very short; leaves palmately 7-nerved, transversely elliptic with an oblique acuminate apex and often with short cusps at the ends of the principal nerves, 7–12 cm long, glabrous above, dark-puberulent beneath, especially on the reddish nerves, petioles suberect, slender, to 17 cm long, densely brown-puberulent, stipules persistent, imbricate, subtriangular, 15 mm long, entire, acuminate-setiferous from a strong midnerve, dark brown; peduncles much exceeding the leaves, up to 55 cm long, puberulent when young; cymes many-flowered, irregular with one side distinctly longer, densely puberulent; bracts deciduous, small, elliptic, entire, thin; staminate tepals 2, orbicular, 5 mm long, entire, minutely puberulent, yellowish white (! Moore); stamens few, free, anthers obovoid, emarginate, slightly shorter than the filaments; pistillate bracteoles very quickly deciduous, not seen; pistillate tepals 5, elliptic, acute, 2.5 mm long, entire, minutely puberulent; ovary 3-celled, placentae bifid, styles bifid; capsule suberect, ovoid, wings unequal, ovate, ascending, at least the largest acute, 5–10 mm wide.

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[1] Received May 15, 1950. The two previous numbers in this series are: *Studies in the Begoniaceae, I*, Contrib. Gray Herb. **154**: 23–31. 1945; *Studies in the Begoniaceae, II*, Contrib. Gray Herb. **159**: 26–29. 1946.

[2] Contrib. Gray Herb. 164, in Caldasia **4**: 3–38, 77–107, 179–209. 1946.

[3] Contrib. Gray Herb. **127**: 26. 1939.

AUG 1 8 1950

Type in the Gray Herbarium, collected in the shade of a large tree, *Liquidambar* woods, Puerto del Zopilote, near Kilometer 329 on the highway north of Jacala, Chapulhuacan, District of Jacala, State of Hidalgo, Mexico, altitude 1,140 meters, April 28, 1947, by H. E. Moore, Jr. (no. 2707). Staminate and pistillate flowers.

Cotypes in the Gray Herbarium and in the U. S. National Herbarium, collected on a rocky ledge, near the Hidalgo line at Kilometers 343–344 on the highway north of Chapulhuacan, District of Jacala, State of Hidalgo, Mexico, altitude 630 meters, May 9, 1947, by H. E. Moore, Jr. (no. 2877). Pistillate flowers and fruit. In its habit, leaves, and irregular cymes, *Begonia hidalgensis* somewhat resembles *B. plebeja* Liebm., but it differs in many details such as its thin inconspicuously nerved stipules and five acute pistillate tepals. Nor does *B. hidalgensis* show close relationship with any other Mexican species.

Begonia pudica Smith & Schubert, sp. nov. FIGURES 1, *h–k*

Herbacea, repens; foliis longepetiolatis, obliquis, late ovatis, stipulis tenuiter nervatis, cymis perpaucifloris, a foliis superatis et obtectis; tepalis masculinis 4; antheris obovoideis; tepalis femineis 2; alis capsulae valde inaequalibus.

Herbaceous, repent; rhizome 8 mm thick, internodes very short; leaves overtopping and presumably concealing the inflorescence, oblique, broadly ovate, short-acuminate, cordate at base, 10–18 cm long, 6–13 cm wide, shallowly undulate-lobed, obscurely ciliate-dentate, sparsely setose on both sides, more or less variegated along the nerves above, petioles erect, 16–31 cm long, sparsely pilose with simple trichomes, stipules deciduous, broadly ovate, entire, thin, glabrous, without obvious nerves; peduncle erect, slender, nearly glabrous; inflorescence bisexual, 3-flowered with a basal solitary flower and paired flowers on a short branch, glabrous; bracts deciduous, very broadly ovate, 3–4 mm long, entire, thin; pedicels 5–21 mm long, flowers pink; staminate tepals 4, the outer suborbicular, 13–20 mm long, the inner broadly elliptic, much smaller; stamens free, numerous, filaments elongate, anthers obovoid; pistillate tepals 2, like the outer staminate ones; ovary 3-celled, placentae bilamellate, ovuliferous throughout; styles persistent, bifid, the stigmatic tissue linear, spiral, continuous; capsule erect, ellipsoid, 13 mm long, wings very unequal, the largest ovate, obtuse, 13 mm wide, the others sublunate.

Type in the U. S. National Herbarium, no. 462313, collected at Barranca Trinidad, below Honey Station, State of Hidalgo, Mexico, September 9, 1906, by C. G. Pringle (no. 10305). Duplicate in Gray Herbarium.

The relationship of *Begonia pudica* is obscure. It appears superficially much like *B. violiaefolia*, but differs in most details most notably in its glabrous tepals and erect capsule.

PANAMA

Begonia davidsonae Standley ex Smith & Schubert, sp. nov. FIGURES 1, *l–o*

Acaulis; rhizomate repente; internodiis brevissimis; foliis oblique lateque ovatis; inflorescentia regulariter cymosa; tepalis masculinis femineisque 4; bracteolis femineis orbicularibus, integris; alis capsulae valde inaequalibus.

Stemless with the leaves clustered near the apex of the short prostrate densely rooting rhizome, glabrous, internodes very short; leaves oblique, broadly ovate, abruptly acuminate and also cuspidate at the ends of the principal nerves, deeply and narrowly cordate at base, 10 cm long, 7 cm wide, petioles slender, 17 cm long, stipules deciduous, triangular-ovate, acuminate, 12 mm long, lacerate toward the apex, thin; peduncles slender, to 26 cm long, exceeding the leaves; cymes regular, few-flowered, dense; bracts quickly deciduous; flowers white or pink (! Davidson); staminate tepals 4, entire, the outer suborbicular, 12 mm long, the inner elliptic, 10 mm long; stamens numerous, anthers obovate, much shorter than the filaments, connective not produced; pistillate bracteoles orbicular, entire; pistillate tepals 4, like the staminate but smaller; stigmatic tissue spiral, wings of the ovary very unequal, the largest oblong, obtuse, much wider than high, the others narrowly marginiform.

Type in the Missouri Botanical Garden, collected in rain forest, at Bajo Chorro, Boquete District, Province of Chiriquí, Panama, altitude 1,800 meters, January 5, 1938, by M. E. Davidson (no. 38). Duplicate in U. S. National Herbarium.

The above species appears to be related to *Begonia brevicyma* C. DC. and *B. mucronistipula* C. DC. but differs from them in having pistillate bracteoles and four pistillate tepals instead of two or three.

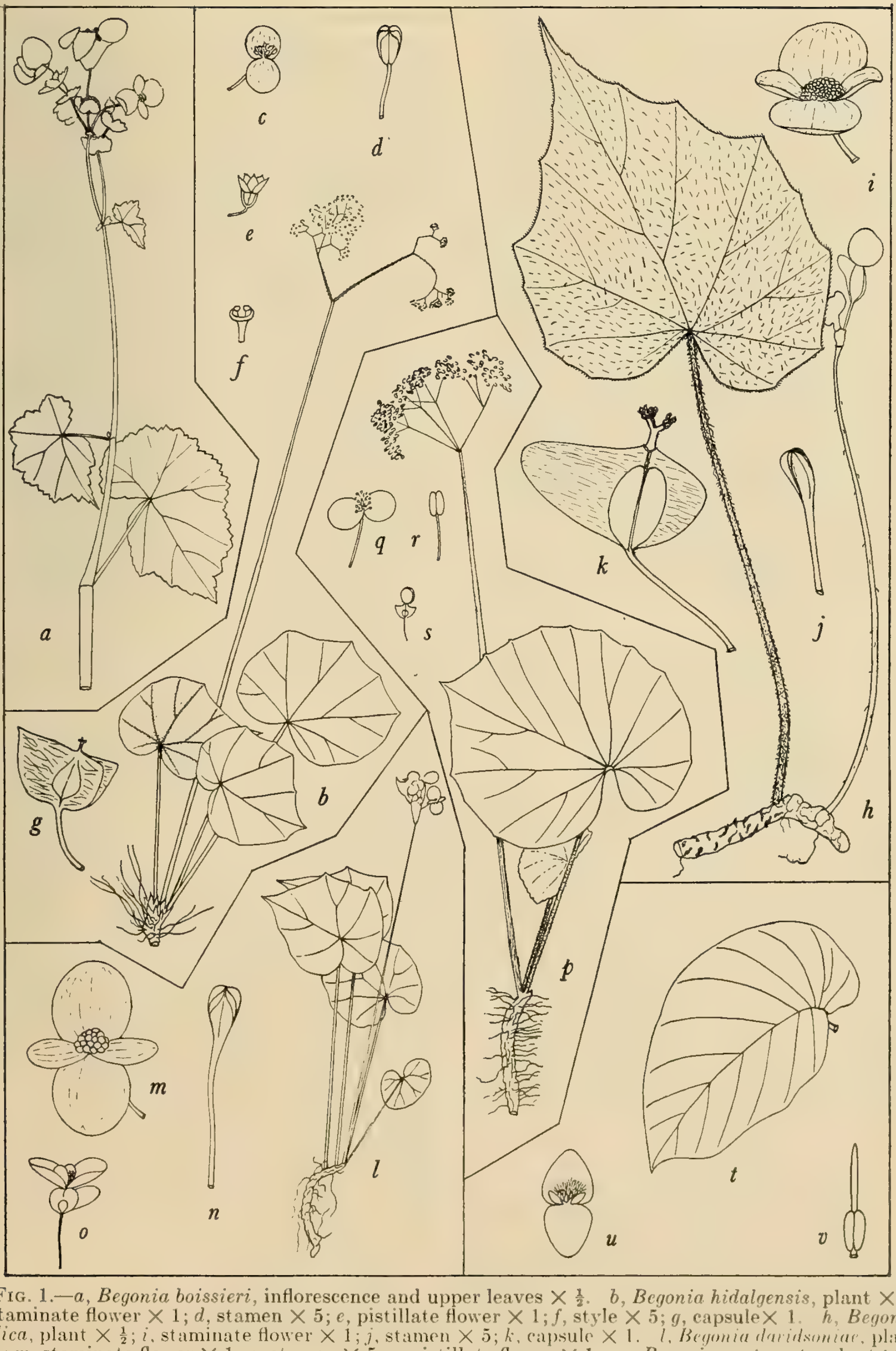

FIG. 1.—*a*, *Begonia boissieri*, inflorescence and upper leaves $\times \frac{1}{2}$. *b*, *Begonia hidalgensis*, plant $\times \frac{1}{5}$; *c*, staminate flower × 1; *d*, stamen × 5; *e*, pistillate flower × 1; *f*, style × 5; *g*, capsule× 1. *h*, *Begonia pudica*, plant $\times \frac{1}{2}$; *i*, staminate flower × 1; *j*, stamen × 5; *k*, capsule × 1. *l*, *Begonia davidsoniae*, plant $\times \frac{1}{5}$; *m*, staminate flower × 1; *n*, stamen × 5; *o*, pistillate flower × 1. *p*, *Begonia quaternata*, plant $\times \frac{1}{5}$; *q*, staminate flower × 1; *r*, stamen × 5; *s*, pistillate flower × 1. *t*, *Begonia thermarum*, leaf $\times \frac{1}{2}$; *u*, staminate flower × 1; *v*, stamen × 5.

Begonia quaternata Smith & Schubert, sp. nov.
FIGURES 1, *p–s*

Acaulis; rhizomate erecto, internodiis brevissimis; foliis transverse latissimeque ellipticis; inflorescentia regulariter cymosa, 3–4-radiata; tepalis masculinis femineisque 2; alis capsulae aequalibus.

Stemless with the leaves clustered near the apex of the erect densely rooting rhizome, internodes very short; leaves transverse, very broadly elliptic, obliquely acuminate and also cuspidate opposite the principal nerves, deeply and narrowly cordate at base, 17 cm long, 14 cm wide, nearly glabrous above, below densely pilose on the nerves and sparsely elsewhere, petioles slender, 15–18 cm long, densely vestite with reflexed lacerate fuscous scales, stipules early deciduous, unknown; peduncles 4 dm long, much exceeding the leaves, slender, glabrous; inflorescence regularly cymose, 3–4-radiate, many-flowered, 13 cm broad, glabrous; bracts quickly deciduous, small, elliptic, entire; flowers white (! Allen) but yellow when dry; staminate tepals 2, suborbicular, 5 mm long, entire; stamens inserted on a short column, anthers ellipsoid, slightly shorter than the filaments; pistillate bracteoles apparently lacking; pistillate tepals 2, to 2.5 mm long; styles bifid, ovary 3-winged, wings equal, broadly ovate.

Type in the U. S. National Herbarium, no. 1820034, collected in the vicinity of "New Switzerland," central valley of Río Chiriquí Viejo, Province of Chiriquí, Panama, altitude 1,800–2,000 meters, January 6–14, 1939, by Paul H. Allen (no. 1336). Duplicate in Missouri Botanical Garden.

The general habit of *Begonia quaternata* is reminiscent of that of *B. stigmosa*. However, the flowers of *B. quaternata* are much smaller, and its cyme has four primary rays, a character that is very rare if not unique in North American *Begonia*.

COLOMBIA

Begonia thermarum Smith & Schubert, sp. nov.
FIGURES 1, *t–v*

Herbacea, ramosa; laminis foliorum transversis, obscure denticulatis; pedunculis brevibus; cymis paucifloris; tepalis masculinis 4: connectivo antherarum ultra loculos perlonge extenso.

Shrubby herb with branches 2 m long (! Scolnik, Molina, & Barkley), completely glabrous, axes straight, strongly sulcate when dry, leaves transversely elliptic, apiculate, cordate at base, pinnately nerved, 9 cm long, 5 cm wide, obscurely denticulate, petiole 5–10 mm long, stipules deciduous, ovate-oblong, entire, 6–9 mm long; peduncles axillary, to 3 cm long; cymes few-flowered; bracts deciduous, like the stipules; pedicels 8 mm long in the staminate flowers, 25 mm long in the fruit; flowers red; staminate tepals 4, very unequal, the outer broadly ovate, obtuse, 10 mm long, fleshy, the inner broadly elliptic, 2 mm long, thin; stamens free, numerous, filaments very short, anthers oblong, connective greatly produced into a long caudate appendage; pistillate bracteoles elliptic, finely denticulate, exceeding the ovary, deciduous; pistillate tepals 3, the two outer suborbicular, 25 mm long, the inner one elliptic, 12 mm long, paler; styles 3, bifid; placentae bilamellate; capsule ellipsoid, unequally 3-winged, the largest wing ovate-triangular, 15–20 mm wide.

Type in the U. S. National Herbarium, no. 1985327, collected in rain forest at Fuentes Termales de Santo Domingo, Department of Antioquia, Colombia, altitude about 1,200 meters, May 7, 1949, by Rosa Scolnik, Jorge Araque Molina, and Fred A. Barkley (no. 19 An 474).

Additional specimens examined: ANTIOQUIA: Municipio of Sonsón, head of the Quebrada "Curubital," region of the Río Verde, altitude 1,430–1,500 meters, January 24, 1947, *G. Gutiérrez V.* 1236 (Hb. Fac. Nal. Agron. Medellín). On rocks in dense forest, vicinity of Nariño, altitude ca. 1,760 meters, August 20, 1948, *W. M. Johnson & F. A. Barkley* 18C832 (US).

The extremely long-caudate stamens and red fleshy outer tepals of *Begonia thermarum* closely resemble those of *B. extensa* Smith and Schubert. It differs from *B. extensa* in its transverse leaf-blades, short peduncles, few-flowered cymes, short staminate pedicels, and the presence of inner staminate tepals. In the key to Colombian *Begonia*,[4] *B. thermarum* would fall next to *B. cryptocarpa* Smith and Schubert, from which it differs in its long-appendaged anthers and bifid styles.

Begoniella kalbreyeri Oliver var. **glabra** Smith & Schubert, var. nov.

A var. typica differt planta omnino glabra.

Differs from the typical variety in being completely glabrous.

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[4] Caldasia **4:** 198. 1946.

Type in the U. S. National Herbarium, No. 1857260, collected at Jericó, Department of Antioquia, Colombia, December 1940, by Brothers Daniel and Tomás (no. 3501).

TROPICAL AMERICA

Begonia patula Haw. Pl. Succ. Suppl. 100. 1819; in Walp. Repert. Bot. Syst. **2**: 215. 1843.
Begonia pauciflora Lindl. in Bot. Reg. **6**: *pl. 471*. 1820.
Begonia obliqua Vell. Fl. Flum. Icones **10**: *pl. 48*. 1827, not L. 1753.
Begonia populifolia sensu Liebm. in Kjoeb. Vidensk. Meddel. **1852**: 16. 1853, not Schott, 1827.
Begonia tovarensis Kl. Abh. Akad. Wiss. Berlin **1854**: 31. 1855.
Begonia moritziana Kl. Abh. Akad. Wiss. Berlin **1854**: 31. 1855.
Begonia pohliana Kl. Abh. Akad. Wiss. Berlin **1854**: 33. 1855.
Begonia malvacea Kl. Abh. Akad. Wiss. Berlin **1854**: 33. 1855.
Begonia parvifolia Kl. Abh. Akad. Wiss. Berlin **1854**: 33. 1855, not Schott, 1827.
Begonia brasiliensis Kl. Abh. Akad. Wiss. Berlin **1854**: 34. 1855.
Begonia macroptera Kl. Abh. Akad. Wiss. Berlin **1854**: 34. 1855.
Begonia elata Kl. Abh. Akad. Wiss. Berlin **1854**: 35. 1855.
Begonia uliginosa Kl. Abh. Akad. Wiss. Berlin **1854**: 35. 1855.

In the course of determining a series of Brazilian begonias from the Instituto Miguel Lillo, we have been faced with the problem of distinguishing the numerous species proposed by Klotsch in the vicinity of his *B. tovarensis*. The variation in single plants is so great that we feel convinced the names listed above represent merely forms or at the most varieties of a single species. At the same time we find the name *B. tovarensis*, which we had been using for this species covering practically all tropical America, is far antedated by *B. patula* Haworth.

Begonia patula appears to be one of the very few species that has arisen in eastern Brazil and then spread far beyond. Its origin is attested by such close relatives as *B. setosa*, *vellerea*, and *subvillosa* in Brazil and their complete absence elsewhere.

ENTOMOLOGY.—*Notes on* Brontispa *in Micronesia* (*Coleoptera, Chrysomelidae*).[1]

H. S. Barber, Bureau of Entomology and Plant Quarantine.

Publications on injury to coconut palms by the leaf-bud infesting beetles of the genus *Brontispa* (Hispinae) record the pests under various names, some of them apparently misapplied. Although inaccuracy of identification may not influence choice of controls to be suggested, it obscures the larger problems: the questions of source of each infestation, of routes of dispersal into previously unoccupied islands, and of varietal differentiation under isolation. There is also the great question: What are the basic or natural specific units as opposed to the arbitrary concepts deduced by taxonomists from their fragmentary data?

Species of *Brontispa* and closely similar genera are recorded from the great area of the Indian and Pacific Oceans from Mauritius to the Marshall Islands, while the coconut has attained a pantropic coastal distribution. Since the prehuman home of the coconut is still hypothetical, we can only conjecture if *Brontispa* evolved upon ancestral coconut or if in its dispersal the coconut entered habitats of other palms infested by *Brontispa*, which found the new host better suited to them than their former host plant. The latter is probably true. Human dispersal of both host and pest in the Pacific must have occurred during the thousand years, perhaps much longer, in which canoes were seeking new islands for occupation (Buck, 1938), but this dispersal is now vastly accelerated.

Ancient speciation and recent differentiation of isolated colonies offer tempting themes for speculation and for conflicting concepts of specific or generic status and relationship. Prehuman wind and wave waif-dispersal may have produced isolated species, human transportation may have established divergent colonies, and modern commerce may so mingle the less differentiated island populations as to obliterate their growing peculiarities through interbreeding. If enough samples representing existing infestations could be compared, something might be guessed of this unknown history, but the

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[1] Received May 8, 1950.

conclusions would probably vary with the personally held theories of different observers. Definite and trustworthy details and samples under correctly applied names are needed for repeated recomparisons. It seems doubtful if a satisfactory solution could be found even if the *Brontispa* now in all public and private collections were available for study in one place.

Excellent samples from Micronesia supplement a few old samples from the Solomons, Celebes, Java, and a few other islands; but it seems doubtful if taxonomic identifications which will be acceptable to our successors may be possible until far more complete field work provides vastly more evidence. Collectors usually preserve samples under one of two extreme conditions: (1) Most frequently, single specimens that have strayed or fallen from their unobserved ecological niches and which merely arouse curiosity by some obvious peculiarity; or (2) a population that attracts attention by its numbers, or by conspicuous injury to some host easily accessible to the observer. Inaccessibility of the crowns of wild palms prevents search for species still occupying their primordial homes.

Severe damage to young coconuts is chiefly responsible for the interest in and for the samples of *Brontispa*. Samples representing such attacks should be reidentified, but enough are not yet available to permit more than tentative opinions on specific distinctions and varietal affinities. Especially needed are more evidence and samples from the islands of the Papuan and Malayan regions. Specific distinctions and relationships may be regarded very differently by later students with better evidence.

More than a score of specific names are available, but the extensive synonymy indicated by Maulik, 1938, and by Lepesme, 1947, will probably be revised.

Good samples of three species from the former Japanese Mandate—the Marshall, Marianas, and Caroline Islands—prompt this note, one object of which is to correct a misidentification I made some 17 years ago for T. Yoshino, then at the Agricultural Experiment Station in the Palau Islands. One of his samples was of a metallic-blue species without source record but later known to be from Korror, Palau; it seemed to agree exactly with the description of *B. chalybeipennis* (Zacher) from Ponape. The other, from Saipan, was obviously new, but as other samples were independently sent to Europe for description (*B. mariana* Spaeth, 1937, syn. *Planispa castaneipennis* Chujo, 1937), my notes reviewing the accumulated literature and samples were not published. Recent samples from both Ponape and Palau show two distinct metallic-blue species, but since Chujo, 1937, and Lepesme, 1947, cite both of these islands as habitat of *chalybeipennis* my unpublished error appears to have been independently duplicated. Esaki, 1940, mentioned the undescribed blue species from Palau, but no further reference to it has been found except a mention by Lange, 1950. Perhaps this blue species is another form, divergent in structure and color from but associable with the yellow Papuan complex that has been lumped under the name *B. longissima* (Gestro, 1885) by Maulik, 1938, and Lepesme, 1947. Its differences are such, however, that it is now given a distinctive name.

Brontispa yoshinoi, n. sp.

Planispa chalybeipennis (part, not Zacher) Chujo, 1937.
[*Planispa*] n. sp. Esaki, 1940.
Brontispa chalybeipennis (part, not Zacher) Lepesme, 1947.
Brontispa sp. Lange, 1950.

Brown below, black above, the elytral reflections intensely blue; interantennal process of male long and very narrow, not quite passing apex of first antennal joint, that of the female broader at base, tapering and extending beyond middle of first antennal joint, its apex narrowly rounded or truncate and its upper surface deeply sulcate in both sexes, the female showing the sulcus wider and deeper at base; clypeus a little broader than in *froggatti* but with similar dense, erect pubescence over the punctured surface; labrum strongly carinate at middle but without the midbasal tubercle, which is prominent, recurved, and conspicuous in *froggatti;* pronotum broader than in *froggatti*, widest at apparent anterior angles, the real anterior angles visible from above as small obtuse teeth near the sides of the head; the hind angles slightly produced as in *mariana*, but not spinose as in *froggatti;* elytral apex brown, subtruncate, with costae extending from apical parts of first, third, seventh and ninth interstices becoming more prominent; the apical emargination between costae one and three narrower; the apices of costae three, seven, and nine more approximate than in *froggatti*.

Length: Male, 7–7.5; female 8.5–9 mm.

Type and 78 paratypes, U.S.N.M. no. 59899. Type male and 23 paratypes, Korror, May 1932, on coconut, T. Yoshino; 41 paratypes, Peleliu, August 1946, R. G. Oakley; 14 paratypes; Babelthuap, July 1946, R. G. Oakley, all in the Palau Islands (lat. 7° N., long. 135° E.). The source of the first specimens was believed to be Ponape, the type locality of *chalybeipennis*, but this error was later corrected by Mr. Yoshino who, in 1933, wrote the sample was from Korror and that the species was also on Truk, Yap, and Ponape. No specimens from Truk and Yap are accessible, and recent samples from Ponape differ in structure.

This species is closely related to *B. mariana* Spaeth (=*castaneipennis* Chujo) in structure but differs, besides color, in its shorter, narrower interantennal process, narrower clypeus, narrower and more strongly costate elytral apices, and more slender aedeagus. In appearance it resembles *B. chalybeipennis* (Zacher), but in that species the interantennal process, the pronotum, the elytral apices, and the clypeus are different in shape and sculpture.

Brontispa chalybeipennis (Zacher)

Oxycephala (*Xiphispa? chalybeipennis* Zacher, 1913.
Brontispa (?) *chalybeipennis* Zacher, 1915.
Planispa chalybeipennis (Zacher) Chujo, 1937 (part).
Brontispa chalybeipennis (Zacher) Maulik, 1938; Lange, 1950.
Brontispa namorikia Maulik, 1946 (? synonym); Lange, 1950; Maulik 1950.
Brontispa chalybeipennis (Zacher) Lepesme, 1947 (part).

Recognition of this very distinct species has been more difficult because the sexual peculiarities in the frontal process as well as the broad and almost nonpubescent clypeus were not described. Nor were these mentioned by Maulik, 1946, in his description of *namorikia*, which, in spite of recorded differences in proportions of antennae and pronotum, is probably conspecific. The interantennal process of the male reaches the apical third of the stout, first antennal joint and is truncate, slightly longer than wide with a deep fovea within its sharply raised upper margins, the lower margins extending beyond its dorsal width. The rather broad clypeus is slightly convex between the eyes, feebly concave between the antennae and also within the margins of the interantennal process; its surface microgranulate with a few remote setiferous punctures. In the female the interantennal process is narrower and shorter, not reaching the middle of the first antennal joint.

The material before me is excellently preserved and includes nearly 200 specimens from Ponape, Kusaie (300 miles east of Ponape), and 5 atolls of the Marshall Islands which lie some 600 to 800 miles east of Ponape. These atolls are Majuro, Likiep, Jaluit, Ailinglapalap and Kwajalein. Among them lies Namorik, the type locality of the name proposed by Maulik, 1946. Palau is wrongly cited as habitat by Chujo, 1937, and by Lepesme, 1947.

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ENTOMOLOGY.—*The Stratiomyidae (Diptera) of New Caledonia and the New Hebrides with notes on the Solomon Islands forms.*[1] MAURICE T. JAMES, State College of Washington.

In the course of obtaining material for my publication on the Stratiomyidae of the Solomon Islands (James, 1948), I received a considerable number of specimens of flies of this family from the areas both north and south of that archipelago. The present paper deals with the interesting and relatively unknown fauna of the more southern area, comprising New Caledonia and the New Hebrides.

This fauna shows a large element of endemicity, as attested by the fact that 10 of the 19 species appear to be new, and of the remaining 9 only 5 are known to occur outside of the Solomons, New Caledonia, and the New Hebrides. From the standpoint of genera, also, the fauna is peculiar. Two of the genera discussed here are described as new, whereas a third was described in my Solomon Islands paper. One genus (*Eufijia*) apparently enters this region from Fiji, another (*Acanthasargus*) from Australia, and another (*Drosimomyia*) belongs to the African fauna! *Eulalia nitidissima* probably belongs to a genus endemic to the South Pacific. Finally, the development of the Myxosargini in this area is interesting. There are a few widespread generic elements, such as *Eulalia* (*sensu stricto*, as represented by *E. novae-caledoniae*), *Sargus*, *Hermetia* (obviously a recent introduction), and *Microchrysa*, as well as some of narrower, though still wide, distribution, such as *Chrysochroma*, *Nothomyia*, *Wallacea*, *Salduba*, and *Lophoteles*.

I am also taking the opportunity in this paper to make some corrections and additions to my Solomon Islands paper.

The following key will separate those species of Stratiomyidae which are known to occur in the New Hebrides and New Caledonia:

1. Cross vein m-cu present, last posterior vein (Cu_1) consequently arising from second basal cell..........2
Cross vein m-cu absent, all posterior veins distinctly arising from discal cell..........10

2. Flagellum of antenna elongated, consisting of 6 closely united segments, the last 2 forming a distinct style but never an arista; anal vein (2d A) beyond thickened basal area arcuate but never sinuous (Stratiomyinae, Eulaliini)..........3
Flagellum of antenna shortened and bearing an apical or subapical arista, which is much longer than basal complex of flagellum....4

3. Front, vertex, mesonotum, and scutellum distinctly pilose and pollinose; antenna wholly yellow, scape and pedicel each about as long as broad and style acute; cross vein r-m distinct...*Eulalia novae-caledoniae* Lindner
Front, vertex, mesonotum, and scutellum over practically entire area shining and completely devoid of pile and pollen; antennal flagellum brownish to black except basally; scape and pedicel each distinctly longer than broad, and style blunt; cross vein r-m absent......*Eulalia nitidissima*, n. sp.

4. Anal vein distinctly sinuous (Fig. 1, *b*), if feebly so mesonotum is patterned in black and yellow; thorax not metallic green or blue (Stratiomyinae, Myxosargini)..........5
Anal vein straight or arcuate, never sinuous; thorax in large part metallic green or blue (Sarginae)..........8

5. Mesonotum black with prominent yellow vittae; abdomen yellow with paired black spots on segments; elongate species with an elongate-ovate abdomen; anal vein distinctly, though feebly, sinuous.
Hoplistopsis geminatus, n. sp.
Mesonotum except postalar calli black; abdomen black or rosaceous with black markings; shorter, more robust species with a short-ovate abdomen; anal vein more strongly sinuous..........6

6. Occipital orbits distinct and clearly margined; vein R_4 absent; legs yellow, at most a femoral band and tips of tarsi darkened..7
Occipital orbits undeveloped or indistinct and not margined; vein R_4 present; at least femora black.....*Nothomyia brevis* (Bigot)

7. Abdomen entirely black.
Acanthasargus inflatus, n. sp.
Abdomen with rosaceous markings in the form of broad transverse bands comprising most of terga 2 to 4..*Acanthasargus roseus*, n. sp.

8. Ocellar triangle much longer than broad; eyes separated in both sexes, somewhat more broadly so in female.*Sargus mactans* Walker
Ocellar triangle approximately equilateral; eyes of male broadly contiguous, of female widely separated..........9

9. Larger species, 8 to 9 mm in length; abdomen in both sexes metallic blue or green; maximum width of anal cell but little greater

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[1] Received April 28, 1950.

than that of second basal cell, distinctly less than combined width of two basal cells.
Cephalochrysa chrysidiformis (Lindner)

Smaller species, about 4 mm in length; abdomen of female metallic blue or green, of male in large part yellow; maximum width of anal cell equal to combined width of two basal cells.
Microchrysa flaviventris (Wiedemann)

10. Four veins arising from discal cell, that is, media 3-branched; terminal segment of flagellum elongated, either flattened and vanelike or forming a terminal arista, the preceding 2 or 3 segments distinctly furrowed longitudinally on inner surface....11

Three veins arising from discal cell, that is media only 2-branched; terminal segment of antennae forming an arista or aristiform style, the preceding segments not as described above (Pachygastrinae)........13

11. Terminal antennal segment forming an arista (Chrysochlorinae).
Chromatopoda annulipes (Walker)

Terminal antennal segment vanelike (Hermetiinae)....................................12

12. Antennal scape 5 times as long as maximum width, longer than style; eyes pilose; abdomen without translucent spots.
Notohermetia pilifrons, n. sp.

Antennal scape at most 2 or 3 times as long as maximum width, much shorter than style; eyes bare; second abdominal segment with a pair of translucent or pale semitranslucent spots.........*Hermetia illucens* (Linnaeus)

13. Abdomen short, at least as broad as long..14

Abdomen distinctly longer than broad.....16

14. Second antennal segment prolonged fingerlike along inner margin of flagellum; antennae arising from a pair of frontal prominences.
Artemitomima mirabilis James

Second antennal segment transverse or at most moderately convex apically, not prolonged along inner margin of flagellum; antennae not located on prominences..............15

15. Scutellum on its posterior margin with several pairs of setiferous cornicles, the apical pair being spinelike; basal complex of flagellum much longer than broad, spindle-shaped; vein R_4 normally present; abdomen of male densely silvery-tomentose.
Wallacea dorsalis, n. sp.

Scutellum without cornicles or spines on its apical margin; basal complex of flagellum not as long as broad; vein R_4 absent.
Drosimomyia baueri, n. sp.

16. Scutellum with 2 long spines; wing cuneiform, alula not developed; basal complex of flagellum no longer than broad.
Eufijia ovalis, n. sp.

Scutellum without spines..................17

17. Second antennal segment produced thumblike into flagellum on inner side; basal complex of flagellum much longer than wide; wing cuneiform, without alula; hind femur thickened, with small blunt spines below.
Salduba australis, n. sp.

Second antennal segment distinctly convex, but not produced thumblike into flagellum on inner side; basal complex of flagellum scarcely longer than wide; wing without distinct alula; hind femur slender without spines below...........................18

18. Basal complex of antennal flagellum distinctly blackish to brownish dorsally; second antennal segment with black hairs apically; scutellum in male wholly black-tomentose....*Lophoteles cheesmanae*, n. sp.

Basal complex of antennal flagellum wholly yellow; or at most slightly infuscated dorsally; second antennal segment wholly yellow-haired; scutellum in both sexes with some yellow tomentum.
Lophoteles plumula Loew

Genus **Eulalia** Meigen

Eulalia Meigen, Nouvelle classification: 21. 1800.

Eulalia novae-caledoniae Lindner

Eulalia novae-caledoniae Lindner, Ann. Mag. Nat. Hist. (10) **20**: 378. 1937.

Lindner described this species from a female taken at Bourail, New Caledonia, May 26, 1928, by T.D.A. Cockerell. The male is quite similar in appearance; the vertical triangle is black, the face orange-yellow with silvery pile, and the legs entirely pale yellow. The mesonotum of the female is golden-tomentose and lacks erect pile except laterally; in the male the golden tomentum is confined to the lateral margin and the entire mesonotum is clothed with erect, yellow pile and with minute appressed black or shiny green scales, the color depending on the light incidence; these scales are also present in the female, but they are sparse and not so evident because of the golden tomentum. The yellow abdominal margin is broader in the male, and it is more nearly exact to describe this sex as having a yellow abdomen with a median black band.

This is a typical *Eulalia* in all respects. The male differs from *E. maculata* (de Meijere) in its yellow face, yellow upper pleura, wholly yellow legs, abdominal pattern, green aspect of the mesonotal scales, and other respects, but it is clearly congeneric with that species as well as with such species as the European *E. hydroleon* (Linnaeus), the American *E. arcuata* (Loew), and the Australian *E. regisgeorgii* (Macquart).

NEW CALEDONIA: Noumea, May 28 and April 6, 1945 (H. E. Milliron), 2 males; Noumea, September 7, 1944 (Wilfred Crabb), 1 male.

New Hebrides: Santo, August to September 1929 (L. E. Cheesman), B. M. 1929–537, 1 female; Malekula, February 1930 (Cheesman), 1 female; Segond Channel, Espíritu Santo, March 26, and August 16, 1944 (Jean Laffoon), 3 females.

Eulalia nitidissima, n. sp.

Female.—Front across ocellar triangle about one-third (46:126) width of head, widening somewhat to plane of antennal insertion (54:126); frontal callus not distinctly defined posteriorly, the front therefore smooth except for the transverse supraantennal groove and the midfrontal suture; face protuberant, evenly rounded; occipital orbits very narrow. Head extremely glossy and over most of its area entirely bare; a few short white hairs on the cheek; a pair of small spots at each end of the supraantennal groove, a similar spot adjacent to the eye on each side of the face, and most of the occipital orbit, silvery tomentose. Middle of facial prominence and lower angle of oral margin castaneous, head otherwise black. Antennal ratio (same units as head measurements), 13:13:16:10:8:7:2:6; flagellum slender its fourth segment tapering to the two-segmented style, which is subacute apically; scape, flagellum, and extreme base of first flagellar segment yellow; first, second, and third flagellar segments otherwise castaneous, the fourth segment and the style black. Proboscis black, the labella with a few black hairs.

Mesonotum and scutellum polished and completely bare, except for a few brassy hairs along the notopleural suture and immediately above the wing bases; black except the yellow lower part of the humeri and the small castaneous areas immediately around each scutellar spine; scutellar spines very short and weak, yellow. Sides of thorax black except posterior parts of pteropleura, which are yellow; mesopleura, sternopleura, and pteropleura shining, with a few scattered hairs; other pleural areas white-pollinose; some noticeable white hairs and white tomentum anteriorly on each propleuron and noticeable whitish hairs on the metapleuron. Legs mostly yellow; last three tarsomeres of anterior tarsus blackish; tarsi otherwise white. Halteres white, with yellowish knobs. Wings hyaline; strong veins yellow before humeral crossvein and beyond discal cell, otherwise (except the costa, which is more extensively yellow) black; stigma strong, blackish to apex of discal cell, yellow beyond. Vein r-m wanting, the discal cell broadly bordering R_s; veins M_1, M_2, and Cu_1 beyond m-cu merely weak folds; veins Cu_2 and 2d A beyond basal part but little stronger. R_4 wanting.

Abdomen black, without a pattern but with much of tergum I yellow and with suggestions of castaneous medially on tergum II and apically on terga II to V; venter yellow.

Length, 6 mm.

Holotype.—Female, Espíritu Santo, New Hebrides (Gilbert Banner); in the American Museum of Natural History.

Remarks.—The completely bare, highly polished mesonotum and dorsal aspects of the head will distinguish this species from any *Eulalia* known to me. Bezzi describes such a species from Fiji, in *Odontomyia gagathina*, and from his description the two species seem to be closely related. He makes no mention of the absence of cross vein r-m, but neither does he in respect to *O. parallelina*, in which that cross vein is absent. *E. nitidissima* differs from the description of *gagathina* in a number of respects, for example the two pairs of silvery spots on the face and frons, the pollinose pleural areas, the yellow venter, and the yellow femora.

The reference of *nitidissima* to *Eulalia* is provisional. It certainly does not belong to that genus in the strict sense but at present it seems best to refer it there tentatively, until a better classification of the *Eulalia* complex, particularly in this area, can be proposed.

Hoplistopsis, n. gen.

Body slender, front narrow; at its narrowest in the male about as wide as diameter of an ocellus, in the female about width of ocellar triangle. Median line of frons well impressed; frontal callus distinct, entire, white. Occipital orbits undeveloped in the male, developed on the upper half only and narrow in the female. Eyes bare. Antennal scape longer than its maximum width, much broader apically than basally; pedicel broader than long, as broad as flagellum; flagellum about as broad as long, the arista long, bare. Thorax and abdomen, black variegated with yellow, pile and tomentum inconspicuous. Scutellum with two short spines. Abdomen ovate. Legs slender, simple, the basitarsus always longer than the remaining tarsomeres combined. Wing venation as in Fig. 1,*b*; vein 2d A distinctly sinuous.

Generotype, *Hoplistopsis geminatus*, n. sp.

Hoplistopsis geminatus, n. sp.

Fig. 1

Male.—Eyes at narrowest part of front separated by 0.02 head width, head black, except frontal callus, which is ivory; hair very inconspicuous, a few black hairs on the ocellar triangle, some yellowish hairs on the face, and some moderately long yellow hairs on the cheeks. Antennae black with black hairs on scape and pedicel; proboscis pale yellow.

Thorax black, variegated with pale yellow as follows: humeri and broad lateral margins of mesonotum backward to the suture; a pair of discal stripes running from the humeri (and confluent there with the lateral margins) to a point midway from the suture to the scutellar base; scutellum except spines; supraalar calli; and a large pleural area extending from below each humerus across the upper and posterior parts of the mesopleuron, across the upper part of the sternopleuron and hypopleuron and including the entire pteropleuron and most of the metanotal slopes. Scutellar spines brown. Thorax with inconspicuous pale tomentum and a little yellow pile on the propleura and metanotal slopes. Legs, including coxae, mostly yellow; hind tibia, except at base, brownish, with a submedian, slightly swollen annulus yellow; front tarsus except basitarsus and hind tarsus beyond apical fourth of basitarsus becoming blackish. Wings hyaline, veins brown. Halteres yellow.

Abdomen yellow, with a series of paired, sublateral, quadrate black spots, on the terga, one pair to the segment; these are confluent medially on the first segment and tend to become evanescent on the fourth almost disappearing entirely on the fifth. Venter uniformly yellow. Genitalia yellow.

Length, 7 mm.

Female.—Eyes at narrowest part of front separated by 0.09 head width; front gradually, but slightly widening from anterior ocellus to callus. Hind tibia brown only subbasally and apically; middle tarsus sometimes blackish apically. Otherwise, as described for the male.

Holotype.—Male, Hienghene, New Caledonia, December 3, 1944 (Wilfred Crabb), U.S.N.M. no. 59895.

Allotype.—Female, same data.

Paratypes.—1 male, 3 females, same data.

Remarks.—This genus shows relationships to both *Nothomyia* and *Acanthasargus*; it may be distinguished from the latter by the incomplete development of the occipital orbits, from the former by patterning of the thorax and abdomen, and from both these genera by its elongated form, with long narrow wings and a more elongated cell Cu_1, and by the very narrow front of the female. The appearance is more that of a *Rhaphiocera* or *Hoplistes*, but the relatively unmodified venation and the sinuous vein Cu_2 place it in the Myxosargini.

Hardy (1943) has suggested that the Myxosargini "probably . . . are marking some phylogenetical development along which genus *Sargus* may have had its origin." This statement seems reasonable. The sinuous vein Cu_2 appears to be a primitive character in the sargine-stratiomyine stem; some species of the primitive *Cyphomyia* possess it, but this vein becomes straight, usually with an apical angular projection downward, in the Sarginae and the Stratiomyini. The Sarginae

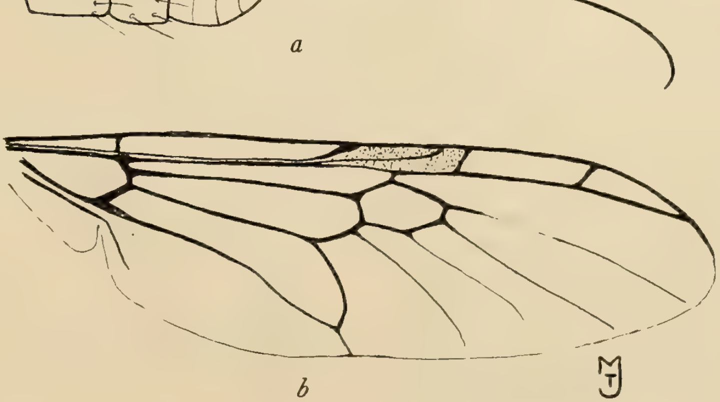

FIG. 1.—*Hoplistopsis geminatus*, n. gen. and sp.: *a*, Antenna; *b*, wing.

move toward the direction of a development of a compact aristate flagellum, an elongated slender body, an unspined scutellum, a dichoptic head in both sexes, and an unpatterned, often metallic, thorax and usually also abdomen, while retaining a relatively primitive wing venation. The Stratiomyinae have a more primitive antennal structure, especially in *Cyphomyia* and its relatives; scutellar spines tend to disappear only in some of the more specialized members of the group; there is a strong tendency toward patterning of the thorax, abdomen, and even the head, and toward a reduced wing venation; the holoptic head prevails in the male sex; the body is usually relatively short and robust. The Analcocerinae, which probably arise from the common stem of the sargine-stratiomyine group, tend toward a patterned thorax and abdomen and a *Sargus*-like body; the wing venation is relatively primitive but tends toward bizarre developments as do the scutellar, leg, and general body modification. The Myxosargini have probably arisen from near the base of the common stem and have retained the primitive venation, including the sinuous 2d A (but frequently with the loss of R_4 and, rarely, of M_3), but have tended toward the aristate antenna in the more highly evolved forms. The patterning of the thorax and abdomen and the aristate antenna combine with some more primitive characters to define the genus *Hoplistopsis*.

Genus **Nothomyia** Loew

Nothomyia Loew, Berliner Ent. Zeitschr. **13:** 4. 1869.

Nothomyia brevis (Bigot), n. comb.

?*Rhaphiocer brevis* Bigot, Ann. Soc. Ent. France (6) **7:** 26. 1887.

Male.—Head black, mostly subshining; frontal triangle with a pair of small oval yellowish-white spots separated by a shining area, pile of the face blackish, that of genae mostly silvery. Antennae black; arista well defined, slender throughout; ratio of scape, pedicel, flagellum and arista 7:5:7:36.

Thorax black, subshining; scutellum on apical half and spines, except extreme apices, yellow; spines about 0.6 as long as distance separating them at their bases. Pile of mesonotum mostly and of scutellum wholly yellowish-white; mesonotum in addition with yellow tomentum. Pleura and sterna subshining and silvery-pilose except a bare shining area on each mesopleuron from the anterior coxa to the notopleural suture. Legs with median third of middle and hind tibiae, middle and hind basitarsi, and second segment of middle and basal part of second segment of hind tarsi, pale yellow; otherwise black. Pile of legs mostly pale. Wings hyaline; veins brownish except near base of wing where they are yellowish; stigma well marked, brown; vein R_4 present. Halteres yellow, knobs almost whitish.

Abdomen black, with reddish or purplish reflections in certain lights; terga with long silvery hairs laterally and on segment five, otherwise with inconspicuous short black pile; sterna with appressed silvery hairs. Genitalia yellowish; dististyle robust, black, subconical, somewhat curved inward apically.

Length, 4.5 mm.

Female.—Front about 0.15 head width at vertex, about 0.3 head width at plane of antennal insertion; gradually widening from above downward, but more abruptly so below the frontal callus; middle fourth of front shining, the broad occular orbits subshining; frontal callus with two yellowish spots as in male but more widely separated. Pile of face silvery. Scutellum black at base, otherwise yellow. Middle and hind tibiae somewhat more extensively yellow than in the male; first three segments of middle and hind tarsi yellow. Pile of thorax and abdomen shorter and less conspicuous. Otherwise, except sexually, as described for the male.

Redescribed from the following material: New Caledonia: Noumea, October 30, 1944 (Wilfred Crabb), 2 males, 1 female; Hienghene, December 3, 1944 (Crabb), 2 males; Corela, March 11, 1945 (David G. Hall), 1 male, 1 female; Bourail, December 1930 (L. E. Cheesman), B. M. 1931–123, 1 male.

I am indebted to James E. Collin for information concerning the wing venation of Bigot's type, particularly in respect to the presence of vein R_4 and the sinuousity of the 2d A. On the basis of this information, I feel virtually certain that I have Bigot's species. The original description agrees wholly with my material except Bigot's statement that the front tarsi are castaneous at the base, and in my material some color variation is evident, particularly in the Bourail specimen, in which the apices of the femora and the base and apex of the front tibia are yellow. This species traces in my key to *Nothomyia* (James, 1942, p. 53) to couplet 7, but the arista is strongly differentiated and vein R_4 present.

Genus **Acantharsargus** White

Acantharsargus White, Pap. Roy. Soc. Tasmania 1914–15: 60. 1914.

Members of this genus differ from the closely related *Nothomyia* in that they have the occipital orbits distinct and sharply margined behind, in both sexes. There is a tendency toward variegation in the color of both the thorax and the abdomen. The following key, modified from Hardy (1932, p. 48), will serve to separate the known species.

1. Thorax and abdomen entirely black.........2
   Thorax at least yellow or rosaceous in part..3
2. Scutellum and scutellar spines black. *pallustris* White
   Scutellum with a yellow bar between yellow scutellar spines...............*gracilis* White
3. Abdomen entirely black.......*inflatus*, n. sp.
   Abdomen margined and spotted or banded with yellow or rosaceous.......................4
4. Abdominal markings rosaceous, in the form of broad transverse bands comprising most of terga 2 to 4...................*roseus*, n. sp.
   Abdominal markings yellow, limited to lateral margins and discal spots..................5
5. Scutellum and spines entirely yellow; legs almost entirely yellow..........*flavipes* Hardy
   Scutellum black, scutellar spines yellow; legs yellow, with sections of the femora and tibiae black..................*varipes* Hardy

Acanthasargus inflatus, n. sp.

Female.—Occipital orbits yellow on upper half, head otherwise black. Width of front at vertex 0.21, at upper margin of frontal callus 0.30, at level of antennal insertion 0.40, head width; front subshining above callus, with appressed blackish hairs. Occipital orbits shining, inflated below the yellow area and there ultimately becoming subshining as a result of the setiferous punctures; pile of face and genae yellow. Antennae black; arista sharply differentiated. Proboscis yellow.

Thorax mostly black; scutellum including spines, most of humerus and the margin of mesopleuron along notopleural suture to wing base, a spot posteriorly on each pteropleuron, and supraalar calli, yellow; mesonotum with yellow tomentum; pleura white pilose. Wings hyaline; veins brownish yellow; vein R_4 missing. Halteres yellow. Coxae black, legs otherwise yellow, the tarsi becoming blackish apically; hind tarsi missing in type.

Abdomen black; some whitish pile laterally especially on basal segments; terga with inconspicous appressed black hairs; sterna with appressed yellowish hairs.

Length, 3.5 mm.

Holotype.—Female, Noumea, New Caledonia, October 30, 1944 (Wilfred Crabb), U.S.N.M. no. 59896.

Remarks.—It is possible that this is the female of *A. roseus;* however, the difference in antennal structure (the arista in this species being distinctly differentiated) whereas in *roseus* it grades somewhat into the basal flagellar complex), together with the difference in coloration, makes such a reference doubtful.

Acanthosargus roseus, n. sp.

Male.—Head mostly black and shining to subshining; the occipital orbits narrowed and pinkish yellow or rosaceous above, black and expanded below; all pile yellow. Antenna black; flagellum with basal three segments distinct, the fourth almost as wide basally as the apex of the third, and gradually narrowing through the fifth to the aristiform sixth. Proboscis yellow.

Thorax mainly black; humerus, notopleural margin of mesopleuron from humerus to wing base, a spot on the pteropleuron adjacent to wing base, and a large spot on the upper part of the sternopleuron, connected or nearly so with a similar spot on the upper margin of the hypopleuron, rosaceous; posterior margin of pteropleuron, postalar calli, and broad sides and apex of scutellum, including spines, yellow, sometimes tending to rosaceous. Scutellar spines about 0.4 as long as their basal separation. All pile white, that on mesonotum appressed. Halteres yellow, the knobs white. Wings hyaline, veins brownish yellow. Vein R_4 missing. Coxae and apical two tarsomeres blackish, legs otherwise yellow.

Broad sides of first tergum, second tergum except narrow apex, and third and fourth except narrow bases and apices, rosaceous; genitalia yellow; abdomen otherwise black. Some long erect white pile laterally on dorsum; pile otherwise appressed, whitish on venter, on genitalia and on rosaceous areas, otherwise mostly black. Dististyli short, robust, subconical, incurved.

Length, 4 mm.

Holotype.—Male, St. Louis Valley, New Caledonia, March 24, 1945 (H. E. Milliron); University of Minnesota collection.

Paratopotypes.—14 males, same data.

Remarks.—Some color variation occurs. Certain specimens have an indefinite pair of rosaceous to yellow spots on the front, and the color of the pale areas of the scutellum and postalar calli may vary from yellowish to rosaceous. The hypopleural spot and the legs, however, are in all specimens distinctly yellow and in contrast even to the variable scutellum.

Genus **Sargus** Fabricius

Sargus mactans Walker

Sargus mactans Walker, Proc. Linn. Soc. London **4**: 97. 1860.

The material examined differs from that of the Solomon Islands and northward in having the metapleura white or clear yellow and the rest of the pleural sclerites more extensively whitish or yellow than in the more northern forms. This form should, perhaps, be considered a geographical subspecies, but I feel that, because of the difficulties involved in this complex and the lack of sufficient material, to describe it as such would be premature.

S. mactans has been recorded from the Solomon Islands northward to India and the Philippine Islands. Neither it, nor any other true *Sargus*, is known from Fiji. NEW CALEDONIA: St. Loius Valley, March 22, 1945 (H. E. Milliron), 1 male, 1 female; Noumea, April 1, 1945 (H. E. Milliron), 1 female.

Genus **Cephalochrysa** Kertész

Cephalochrysa chrysidiformis (Lindner)

Microchrysa chrysidiformis Lindner, Ann. Mag. Nat. Hist. (10) **20**: 373. 1937.

NEW HEBRIDES: Espíritu Santo Island, August 1943 (W. Bauer), 1 female; Segond Channel, Espíritu Santo Island, May 30, 1944 (J. Laffoon), 1 female.

Genus **Microchrysa** Loew

Microchrysa flaviventris (Wiedemann)

Sargus flaviventris Wiedemann, Analecta Ent.: 31. 1824.

In my account of the Stratiomyidae of the Solomon Islands (James, 1948, p. 199), I misdetermined this species, and records included in that paper should refer instead to *M. fuscistigma* de Meijere, a species originally described from New Guinea. *M. flaviventris* occurs farther northward, the common form in India and the Philippine Islands appaerntly being that species; its occurrence south of the Solomon Islands is, therefore, surprising.

NEW HEBRIDES: Espíritu Santo Island, September 1944 (K. L. Knight), 1 male.

The following key will serve to separate the sexually dichromatous species of *Microchrysa* known to occur in the Palearctic and Oriental Regions.

1. Vein M_{1+2} between its contact with cross vein r-m and its furcation (*ie.*, upper apical border of discal cell) almost evanescent; abdomen of male yellow, with a prominent black spot on tergum V, that of female metallic green or blue; hind femur and hind tibia each with a black annulus, sometimes the femur extensively black..... *flaviventris* (Wiedemann)

 Vein M_{1+2} between its contact with r-m and its furcation strong.......................... 2

2. Stigma often infuscated, at least yellowish; abdomen elongated, scarcely broader than thorax............. *fuscistigma* de Meijere

 Stigma scarcely darker than rest of membrane; abdomen broader than thorax. *laodunensis* Pleske

Genus **Chromatopoda** Brauer

Chromatopoda annulipes (Walker)

Sargus annulipes Walker, List of the specimens of dipterous insects in the collection of the British Museum, pt. 3: 515. 1849.

NEW HEBRIDES: Ounua, Malekula, February 1929 (L. E. Cheesman), B.M. 1929-234, 3 males; N. E. Malekula, May 1930 (Cheesman), B. M. 1930-178, 1 male; Espíritu Santo, April and August 1943 (W. Bauer), 1 female, 2 males; Turtle Bay, Espíritu Santo, February 11 and 17, April 2, May 18, 19, 23, and 24, 1944, and November 7, 1943 (J. Laffoon), 4 males, 4 females; Segond Channel, January 24, February 8, and April 9, 1944 (Laffoon), and August 1944 (L. E. Rozeboom), 3 males, 2 females.

Notohermetia, new genus

Close to *Hermetia* and differing from that genus chiefly in the antennal structure, particularly in the elongated scape, which is five times as long as its maximum width. Antenna longer than head, about two-thirds head width; flagellum grooved inwardly as in other Hermetiinae; terminal segment about half as long as preceding flagellar segments combined, vane-like as in *H. illucens* but more distinctly pilose and proportionately much shorter. Eyes densely and distinctly pilose. Scutellum unspined. Body slender; abdomen much longer than thorax and three times as long as wide, parallel-sided. Venation essentially as in *Hermetia*. The general habitus is that of a slender *Hermetia*.

Generotype, *N. pilifrons*, n. sp.

Notohermetia pilifrons, n. sp.

Male.—Head broad, concave posteriorly; length in micrometers units (60 = 1 mm) 50, width 134; bluish green, subshining to shining, fairly thickly clothed with black hair which is of moderate length on the face but becomes longer on the front and vertex, that behind the ocelli being definitely the longest found on the entire insect. Vertex 0.3 head width, front widening to 0.37 at plane of antennal insertion. Antennal measurements in micrometer units: scape, 26; pedicel, 8; flagellum excluding style, 35; style (last flagellar segment), 20.

Thorax mostly bluish green; a calluslike area on posterior margin of mesopleuron, whitish; some poorly defined areas on pteropleura and hypopleura reddish; pile mostly pale, inconspicuous, only that of the metapleura prominent. Legs largely black, the knees, the basal third of the middle and basal two-fifths of the hind tibiae, the middle basitarsus and second tarsomere, and the basal half of the hind basitarsus whitish. Halteres white. Wings rather deeply infuscated except basally; veins brown.

Abdomen long, slender, almost parallel-sided, slightly constricted on the first segment and slightly widening on the fourth and basal part of the fifth; bluish green on the first tergum, becoming reddish on the second and third, reddish brown on the fourth and fifth; sterna somewhat paler, almost yellow toward apex. Genitalia yellow.

Length, 7 mm.

Holotype.—Male, Santo, New Hebrides, August–September, 1929 (L. E. Cheesman), B. M. 1929-537; in the British Museum (Natural History).

Genus **Hermetia** Latreille

Hermetia illucens (Linnaeus)

Musca illucens Linnaeus, Systema naturae, ed. 10, **1**: 589. 1758.

NEW CALEDONIA: Noumea, September 1, November 7, 1944 (Wilfred Crabb), 1 male, 1 female; La Fea, May 28, 1945 (H. E. Milliron), 1 male; St. Louis Valley, March 24, 1945 (H. E. Milliron), 1 male.

Genus **Artemitomima** James

Artemitomima James, Proc. U. S. Nat. Mus. **98**: 205. 1948.

Artemitomima mirabilis James

Artemitomima mirabilis James, Proc. U. S. Nat. Mus. **98**: 206. 1948.

This species was described from a single female, from Guadalcanal Island. The male described below is certainly congeneric and apparently conspecific, as all variations from the female are of such a nature as can be explained on the basis of sexual dimorphism. The fact that the male specimen is slightly teneral may account for some of the color variations.

Male.—Vertex 0.15 head width, narrowing gradually on the front to about 0.075 head width at half the distance from the anterior ocellus to the antennal insertion, thence widening to the facial width which is approximately as in the female. Frontal carinae present though feeble, evanescent on lower half of front; area between carinae yellowish (not fully colored?). Trochanters yellow, femora yellow except apex of front, apical third of middle, and apical fourth of hind pair; tibiae yellow, blackish on basal third to half and at apex; first two segments of middle and first and basal half of second segment of hind tarsi yellow; legs otherwise black. Wing with brownish spot at apex of discal cell; the narrow band, extending from apical part of basal cells across veins Cu$_2$ and Cu$_2$ + 2d A, interrupted in second basal cell and not as prominent as in the female; wings otherwise hyaline. Tomentum of abdomen silvery. Hypopygium slender, shining black; forceps slender, rounded apically, yellow.

Length 7.5 mm.

Described from a male, Malekula, New Hebrides, February 1930 (L. E. Cheesman), B. M. 1930-178; in the British Museum (Natural History).

Genus **Wallacea** Doleschall

Wallacea Doleschall, Nat. Tijdschr. Ned. Ind. **17**: 82. 1858.

The genus *Wallacea* is represented in the South Pacific and in Australia by a group of closely related species which have the following characters in common: Eyes separated, distinctly pilose in both sexes, more widely separated in the female but more distinctly pilose in the male; scutellum with a row of setiferous dentulae which become more prominent toward the apex, the apical pair appearing as small spines, about one-fourth as long as the scutellum, and much more prominent than the similarly located dentulae in the more northern species; male abdomen with the second and third terga densely silvery-tomentose, the tomentum completely concealing the ground color and appearing glossy under reflected light. The following key will separate the known species of this group.

1. Scutellum with the pale tomentum either not reaching the apex even along the median line (male) or interrupted subapically (female); eyes brownish- to black-haired; mesonotum anteriorly with 2 prominent vittae where the scattered white tomentum is lacking; front of male about 0.13 to 0.14 head width; fifth abdominal segment of male devoid of white hairs or tomentum 2
   Scutellum with white or yellow tomentum reaching apex medially; eyes white-haired; mesonotum with at most only narrow obscure vittae anteriorly; front of male about 0.17 to 0.18 head width; fifth abdominal segment of male with a patch of white tomentum on each side (*splendens* Hardy). *argentea* Doleschall
2. Mesonotal tomentum of female brassy, at least posteriorly; black mesonotal vittae confluent with black lateral postsutural areas, in both sexes, or mesonotum predominately black-tomentose . . . . *dorsalis*, n. sp.
   Mesonotal tomentum of female at most slightly yellowish; mesonotal vittae reduced, not confluent with lateral areas, in male not reaching more than halfway to suture. *connectens*, n. sp.

Wallacea dorsalis, n. sp.

Male.—Head black. Front about 0.14 head width, nearly parallel-sided, a little narrower at middle, as broad or slightly broader than ocellar triangle; granular above, polished in middle below; face black, broadening toward lower eye margins where it is about 1.7 width at antennal insertions; facial margins and lower frontal margins conspicuously silvery-pruinose; hairs of front and face black. Eyes with distinct though somewhat scattered gray pile. Antennae reddish, darkening to brown toward end of flagellum; style shining black on basal segment and basal part of terminal segment, the latter becoming brown medially and white to whitish on its apical half or more.

Thorax including scutellum black, with erect black hairs which are mostly longer than the apical scutellar spines; a patch of silvery scale-like tomentum just above, and a similar patch just below, the notopleural suture; similar though usually smaller patch just above each wing base; tomentum of mesonotum and scutellum otherwise black and consequently inconspicuous, except for a few scattered scales, particularly in front of and at the base of the scutellum. Sternum with appressed whitish hairs.

Apices of femora yellow; middle and hind tarsi yellow, becoming brownish and then blackish on the apical segments; legs otherwise black, black-haired except the coxae, which are whitish-haired. Wings hyaline, veins brownish yellow. Halteres blackish, the knobs brownish. Abdomen black; second and third terga with dense silvery tomentum which entirely conceals ground color and which gleams brightly under reflected light; first, fourth, and fifth terga and all sterna with short black recumbent hairs, the fourth tergum in addition with a few scattered silvery scales. Genitalia yellow.

Length, 3.5 mm.

Female.—Front 0.25 head width; face broadening toward lower eye margins to about 1.4 width of front at vertex or 1.25 at antennal insertions. Front on upper part with some scattered yellowish tomentose hairs. Hairs of face mostly pale, apical segment of antennal style almost wholly white. Thorax mostly with white (lateral) and yellow (dorsal) tomentum; a pair of vittae running from anterior margin of mesonotum to prescutellar depression, either continuous or interrupted at the suture, a rounded lateral area on each side in front of the suture, most of the mesonotal prominence behind the suture, and the apical half of the scutellum, all entirely black-tomentose. Abdomen black; no dense tomentum as described for the male, but with lateral patches on the terga, particularly noticeable on segments three, four, and five, and scattered silvery scales on segments four and five and on the apex of three. Otherwise as described in the male.

Holotype male, *allotype* female, and *paratypes* (3 males and 1 female).—Espíritu Santo Island, New Hebrides, August 1943 (W. Bauer). Holotype in the California Academy of Sciences.

Variation.—Four males, same data as the types, agree in every way except that the mesonotum has a pattern of silvery tomentum similar to that of the female, though more restricted, particularly anteriorly. The erect pile is black and conspicuous, as in the male types. These specimens probably represent a Mendelian variant. At the other extreme a male from Segond Channel, Espíritu Santo Island, August 1, 1944 (J. Laffoon), completely lacks the mesonotal pale tomentum and has the pleural patch restricted to a small area just before the termination of the transverse mesonotal suture.

Wallacea connectens, n. sp.

Wallacea argentea Doleschall, James, Proc. U. S. Nat. Mus. **98**: 208. 1948; not Doleschall, Nat. Tidjschr. Ned. Ind. **17**: 82. 1858.

A comparison of the Solomon Islands form with that occurring farther northward and in Australia reveals distinctions which appear to be quite clearly of specific value. The major points of difference are given in the key; in addition to these, the erect pile of the mesonotum, in the male, is definitely longer than the width of the front, whereas in *argentea* it is shorter. The relationship between *connectens* and *dorsalis* is obviously closer than that between these species and *argentea;* in fact, *connectens* and *dorsalis* may eventually be considered geographical subspecies.

Holotype.—Male, Guadalcanal Island, Solomon Islands, 1944 (C. O. Berg); U.S.N.M. no. 59897.

Allotype.—Female, Guadalcanal Island, 1944–1945 (Berg).

Paratypes.—12 males, 22 females Guadalcanal, 1944, January 1944, and 1944–1945 (Berg); 1 male, 1 female, Lunga River Valley, Guadalcanal Island, October 3, 1944 (J. Laffoon); 2 females, Metanikau River Mouth, Guadalcanal Island, May 21, 1944 (H. E. Milliron); 1 female, Munda Point, New Georgia, 1943 (W. G. Downs); 2 males, Bougainville Island, 1944 and April 10, 1944 (Downs); 2 males, 2 females, Tenaru River, Guadalcanal Island, January 1945 (G. E. Bohart).

Genus **Drosimomyia** Kertész

Drosimomyia Kertész, Ann. Mus. Nat. Hungarici **14**: 160. 1916.

The genus *Drosimomyia* is known from three previously described species, all Ethiopian. A fourth, from New Hebrides, seems to be congeneric, though differing from the genotype, *D. natalensis* Kertész, and from *oldroydi* James and presumably *mercurialis* Lindner, which I know only from the description, in the configuration of the front and face.

KEY TO THE KNOWN SPECIES OF *DROSIMOMYIA*

1. Antennal flagellum dark brown and contrasting distinctly with yellow scape and pedicel; vein R_4 present, though weak. *mercurialis* Lindner
   Antennal flagellum at most somewhat darkened outwardly; vein R_4 absent. 2
2. Frons narrowest at antennal insertion, widening toward vertex, face also widening toward lower corner of eyes; rather slender species. *baueri*, n. sp.
   Frons and face nearly parallel-sided, the frons slightly wider at antennal insertion than at vertex; more robust species. 3
3. Proboscis wholly black; mesonotal tomentum brassy in male, silvery in female. *natalensis* Kertész
   Haustellum largely yellow; mesonotal tomentum golden in male, pale yellow in female. *oldroydi* James

Drosimomyia baueri, n. sp.

Female.—A slender species, wholly black in ground color except for the appendages and ovipositor. Elevation of ocellar triangle above front prominent. Vertex about 0.37 head width, front at antennal insertion 0.25, face at lower angle of eye 0.30; fronto-facies consequently appearing rather narrow and constricted at plane of antennal insertion. Front shining, with a few inconspicuous scattered black hairs especially on the ocellar triangle; face densely silvery-pruinose on the orbits, shining with a few scattered, inconspicuous pale hairs medially. Occiput shining, with a few black hairs on the orbit above and a few yellowish ones below. Proboscis yellow, yellow-pilose. Antennae yellow, the basal two segments somewhat paler, the arista pale brown; all pile and pubescence yellow.

Mesonotum and scutellum brassy-tomentose; a pair of median vittae before the suture and the postsutural prominences black-tomentose. Pleura with the posterior half of the mesopleura and upper margin of the sternopleura silvery-tomentose; some silvery hairs on the sternopleura below; pleura otherwise shining. Legs pale yellow, wings hyaline, the stronger veins brownish to brownish yellow; vein R_4 absent.

Abdomen whitish-pruinose on segment 1, dorsally and ventrally; terga 2 and 3, except broad sides, and tergum 4 except broad sides and apex densely punctured and with black tomentum; terga otherwise, and sterna 2–5 shining; pile of tergum 5 and of sides and apex of tergum 4 yellow. Ovipositor mostly yellow.

Length, 2.5 mm.

Holotype.—Female, Espíritu Santo Island, New Hebrides, August 1943 (W. Bauer), in the California Academy of Sciences.

Paratypes.—4 females, same data.

Genus **Eufijia** Bezzi

Eufijia Bezzi, Dipt. Fiji: 10. 1928.

Eufijia ovalis, n. sp.

Female.—Head black, shining; rather bare, with a few hairs, yellow on the front, blackish on the upper occiput, and whitish and most abundant on the face and cheeks. Antenna bright yellow on basal two segments and flagellum, shining black on first segment of style, black on the extreme base of the terminal segment of the style, which is otherwise white with dense, soft, white pubescence. Proboscis pale yellow with concolorous hairs. Head measurements of holotype in micrometer units (60 = 1 mm): head height 31, width 45; width of front at antennal insertion 8, at anterior ocellus 16, across paired ocelli 18; first antennal segment 2.5, second 5, flagellum excluding style 9, basal segment of style 1, terminal segment of style 34.

Thorax, including scutellar spines, wholly black. Mesonotum with rather thick golden tomentum which becomes paler laterally; disc of scutellum with similar tomentum, the spines, however, bare except basally; pleura white-tomentose, the pteropleura anteriorly and the lower parts, however, largely bare and shining.

Legs pale yellow, almost whitish, the apical third to half of each femur and a similar basal part of each tibia distinctly yellow and contrasting with the paler portion. Wings somewhat clouded, with brownish veins; R_4 oblique, about 1.5 its length from apex of R_5. Halteres yellow with infumated knobs.

Abdomen black; dorsally with a granular appearance, particularly anteriorly, and with appressed whitish to yellowish hairs; ventrally much smoother and more shining, with scattered whitish hairs, except on fifth sternum which is more granular and whitish-tomentose. Ovipositor slender, pale yellow.

Length, 3.5 mm.

Holotype.—Female Espíritu Santo Island, New Hebrides, August 1943 (W. Bauer); in the California Academy of Sciences.

Paratypes.—Female, Segond Channel, Espíritu Santo Island, July 20, 1944 (Bauer); 2 females, Malekula, New Hebrides, January 1930, B. M. 1930-178, and April 1930, B. M. 1930-393 (L. E. Cheesman). A headless specimen from Segond Channel, May 3, 1944 (J. Laffoon), is obviously this species but is not being given a type designation.

Remarks.—Five species of this genus are previously known, all described by Bezzi from Fiji (Bezzi, 1928, pp. 10–15). In Bezzi's key, *E. ovalis* traces to *E. albicornis* Bezzi except that the head is distinctly broader than high, the arista in the female (male unknown) is white except at the extreme base, where it is black, and the legs are white, the apical third of each femur and basal third of each tibia being yellow and contrasting distinctly in well preserved specimens. Vein R_4, though distant by about 1½ times its length from the apex of R_5 is distinctly oblique.

Genus **Salduba** Walker

Salduba Walker, Proc. Linn. Soc. London **3:** 79. 1859.

Salduba australis, n. sp.

Female.—Head black. Front parallel-sided, slightly more than one-fifth of head; a slight carina extending from anterior ocellus to a point about two-thirds to base of antennae, where it divides into two converging low, rounded ridges, upon the extremities of which the antennae arise; face broadening toward oral margin; middle of face smooth, shining, depressed below level of sides; sides of face, except orbits, granular. Occiput, viewed from above, rather strongly concave; shining. Frons practically bare; face on punctate portion with scattered whitish hairs; facial orbits, lower part of frontal orbits, and lower half of occipital orbits densely whitish-pruinescent; pile of lower posterior orbits white, that of occiput otherwise blackish. Antenna yellow, becoming reddish on flagellum; style with its pile black; ratio of scape, pedicel, flagellum, and style 8:6:16:33 (these being measurements of maximum lengths, and allowing for some overlapping as a result of the angularity of the pedicel and base of the flagellum); antenna about 1.2 maximum head width. Proboscis yellow, labella mostly brownish.

Thorax black, at most the humeri a little reddish; mesonotum granular, densely tomentose, tomentum largely golden but interrupted by three broad longitudinal black stripes, one median and one on each side removed by a golden-tomentose area from the notopleural suture; tomentum of pleura golden above, gradually merging into whitish below; a large bare shining area on each mesopleuron and pteropluron. Coxae yellow. Femora yellow, paler at base; tibiae brownish to black, each with a median area ranging from a narrow, indistinct annulus to about one third the member, yellow; the dark area of the front and middle tibia usually brown, that of the hind tibia blackish to black; tarsi whitish on first two segments, becoming brownish apically. Halteres yellow, knobs somewhat darker. Wings almost uniformly brownish, stigma and veins dark brown.

Abdomen except genitalia black, tending toward brownish or yellowish on the sterna, especially toward apex of abdomen, in some specimens; first four terga densely black pollinose except laterally on all segments and subbasally and subapically on the fourth; pollinose areas with short black tomentum; sides and venter sparsely punctured, with scattered whitish to yellowish hairs. Genitalia yellow.

Length, 6–6.5 mm.

Male.—Eyes broadly contiguous. Frontal triangle silvery-pollinose on orbits; median area depressed. Flagellum shorter in proportion, antennal ratio being 8:6:15:34. Black mesonotal stripes, especially median one, not so clearly defined as in female. Pile of pleura more extensively whitish. Coloration of legs similar to that of female, but yellowish areas more extensive, the middle tibia being almost entirely yellow. Wings but lightly infuscated. The specimen may be slightly teneral.

Holotype.—Female, Espíritu Santo Island, New Hebrides, August 1943 (W. Bauer), in the California Academy of Sciences.

Allotype.—Male, Malekula, New Hebrides, February 1930 (L. E. Cheesman), B. M. 1930-178.

Paratypes.—3 females, same data as holotype.

Remarks.—This form is probably only subspecifically distinct from the one from the Solomon Islands that I have tentatively identified (James, 1948, p. 212) as *S. lugubris* (Walker). The coloration of the legs and of the mesonotal tomentum in the male of the Solomon Islands form is as I have described them for the female of *australis*; the female of the Solomon Islands form has whitish rather then golden mesonotal tomentum, and the legs are darker, the femora being predominantly black or blackish. It is probable that the Solomon Islands forms *australis*, *lugubris*, and *diphysoides* Walker are all subspecies of one species, *diphysoides* holding priority. A more thorough investigation requiring considerable material from New Guinea, the Moluccas, and nearby areas will be necessary to clarify the status of these forms.

Genus Lophoteles Loew

Lophoteles Loew, Berlin. Ent. Zeitschr. 2: 110. 1858.

Lophoteles cheesmanae, n. sp.

Male.—Eyes broadly contiguous. Head black; frontal triangle and face with dense silvery tomentum; occiput and vertex shining, with scattered black hairs. First and second antennal segments pale yellow, each with a few black hairs at apex above; flagellum pale yellow, brownish above; style including hairs wholly black. Proboscis brownish with concolorous hairs.

Thorax wholly black, at most brownish-black on the humeri and on parts of the pleura. Mesonotum granular with brassy-yellow tomentum laterally also with blackish tomentum, which appears from the dorsal view as black-tomentose margins, the yellow tomentum in these areas appearing from lateral view; scutellum black-haired; a prominent white-tomentose area on the hind part of the mesopleuron and extending on to the sternum and a patch of brownish-yellow hairs on the pteropleuron. Legs pale yellow; apical third to half of each femur and sometimes apices of tarsi more brightly yellow. Wings slightly infumated; stigma deep brown; a more diffused brownish area extending from stigma across discal cell and broadly bordering vein Cu toward wing base; venation typical. Halteres blackish, the stalk somewhat paler.

Abdomen wholly black; first four terga, except laterally, granular; sides of these terga, all of fifth and venter more shining; hair of terga black, appressed, that of venter black and yellowish intermixed. Genitalia black, with yellow hairs.

Length, 4 mm.

Female.—Front at narrowest slightly under one-fourth head width, shining, with only very scattered hairs. Silvery-tomentose areas of face extending in the form of two projections, contiguous with each eye, onto lower third of front; these projections each rounded above and widely separated, leaving the median half of the front, between them, glossy. Occipital orbits developed above, though narrow. Brassy tomentum of mesonotum extending over most of scutellum. Ovipositor slender, yellow. Otherwise as described in the male.

Holotype.—Male, Aneityum, New Hebrides, October 1930 (L. E. Cheesman), B. M. 1931-127, in the British Museum (Natural History).

Allotype.—Female, Malekula, New Hebrides, January 1930 (L. E. Cheesman), B. M. 1930-178.

Paratypes.—2 males, same data as holotype; female, same data as allotype; female, Malekula, Ounua, March and April 1929 (L. E. Cheesman), B. M. 1929-343.

Variation.—The female paratype, B. M. 1930-178, has a blackish spot ventrally near the apex of each femur.

Lophoteles plumula Loew

Lophoteles plumula Loew, Berlin. Ent. Zeitschr. **2**: 111. 1858.

Lophoteles plumula Loew, Kertész, Ann. Mus. Nat. Hungarici **12**: 513. 1914.

Two males, Segond Channel, Espíritu Santo, New Hebrides, July 19 and August 10, 1944 (J. Laffoon), are tentatively referred to this species. They agree with Kertész's description except that the appressed hairs of the abdominal terga are black; the lateral erect hairs, as well as those of the venter, are, however, pale. These specimens are more slender than the males of the preceding species; the antenna except the style is wholly yellow, with yellow hairs on the first two segments; the pale tomentum of the mesonotum extends onto the scutellum; and the halteres are but slightly infuscated.

Genus **Evaza** Walker

Evaza Walker, Proc. Linn. Soc. London **1**: 109. 1857.

Evaza fulviventris Bigot

Evaza fulviventris Bigot, Ann. Soc. Ent. France (5) **9**: 220. 1879.

This species may be added to the Solomon Islands list on the basis of a male, Bougainville Island, 1944 (A. B. Gurney), which apparently belongs here. The scutellum has only one pair of spines, the middle pair being missing and without trace of scars, but this seems to be an abnormality. The side spines are in the normal position. Otherwise, the specimen checks with specimens from New Guinea and with Bigot's description. In my key to the Solomon Islands Stratiomyidae (James, 1948, pp. 187–191) this species runs to couplet 29, but may be distinguished from other Solomon Islands *Evaza* by the wholly black thoracic tomentum, the reddish-yellow legs (except the hind tibiae largely blackish), and the partially (female) to almost wholly (male) reddish-yellow abdomen.

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ENTOMOLOGY.—*New species of Nearctic* Rhyacophila (*Trichoptera, Rhyacophilidae*).[1] Herbert H. Ross, Illinois State Natural History Survey. (Communicated by C. W. Sabrosky.)

The four new species of Trichoptera described in this paper are from the western montane region. One of them, *Rhyacophila willametta*, is an addition to the remarkably large list of species in the genus that seem to be isolated survivors of divergent and distinctive phyletic lines.

The close structural similarity and the known distribution of *R. tucula* and *R. alberta* suggest very strongly that they were formed from isolated populations during the last glacial advance. *R. alberta* is known only from the Uintah and Rocky Mountain ranges, distributed from Utah and central Colorado to middle Alberta. *R. tucula* occurs in the Cascade Range from Oregon to southern British Columbia, with a single known collection from the eastern ranges, in Yellowstone National Park. It is interesting to speculate that the two species arose during early Eldoran time through isolation of similar populations at points far south of their present habitats. If this is true, the slight overlap of present distribution would indicate a northward movement to areas where the various mountain ranges are close together and intermingling occurs.

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[1] Received April 25, 1950.

Genus **Rhyacophila** Pictet

Rhyacophila tucula, n. sp.

This species is a close relative of *alberta* Banks, differing most obviously in the proportions of the apical segments of the claspers; in *tucula* most of the brushlike dorsal portion of the apical segment extends beyond the end of the basal segment (Fig. 7), whereas in *alberta* (Fig. 6) this portion extends only a short distance beyond the end of the basal segment. In addition, the lateral arm of the aedeagus in *tucula* ends in a brush of dense setae (Fig. 2), and in *alberta* this region is expanded into a broad lobe bearing a fairly even pecten of stouter curved spines, beyond which the arm narrows again and bears a single long spine (Fig. 1).

Male.—Length from front of head to end of the folded wings, 12 mm. Color various shades of brown, darkest on the dorsum, the antennae, palps, and legs yellowish brown, the wings light brown and completely irrorate with a spotlike and barlike medium brown pattern. General structure typical for genus. Genitalia as in Fig. 7. Ninth segment short and annular except for the excavations to receive the bases of the claspers. Tenth tergite with dorsal sclerite narrow and humped, ending in a short, sharp projection; lateral sclerites only lightly sclerotized and ovate at apex; mesal sclerites ovate and projecting a short distance beyond lateral sclerites. Clasper with very long basal segment, which is nearly parallel-sided; apical segment much shorter, boot-shaped, with an angular heel and a moderately produced toe; mesal side of clasper bearing (1) a large sclerotized tendon which arises from the basal segment and joins the dorsal connective of the aedeagus, and (2) a pair of cushionlike areas of black spicules on the apical segment, as shown in Fig. 7A. Aedeagus consisting of a horseshoe-shaped dorsal connective, a short tubular base ending in a crenulate extensile apex, and arising from this is a pair of long, slender lateral arms and a mesal style containing the penis; the lateral arms bear a long comb of short spines which extend along the apical third of each arm (Fig. 2).

Female.—Size, color, and general structure as for male. Eighth segment (Fig. 3) with apex of venter produced and arcuate, apex of dorsum also produced, but more narrowly so, the segment considerably narrowed dorsoventrally toward apex. Spermatheca (Fig. 5) consisting of a somewhat bulbous, vasiform base and a long, slender, flattened apex, which is membranous ventrally and dorsally has a pair of lateral sclerotized bands extending from the middle of the process to and around the apex.

Holotype.—Male, Gardner River, Yellowstone National Park, Wyo., August 22, 1946, W. E. Ricker.

Allotype.—Female, same data.

Paratypes.—BRITISH COLUMBIA: Chilliwack Lake, Silver Creek, September 14, 1936, W. E. Ricker, 1♂. Cultus Lake, along Chilliwack River, August 25, 1934, W. E. Ricker, 1♂; same but September 9, 1937, 2♂. OREGON: McKenzie Bridge, September 21, 1934, R. E. Dimmick, 2♂, 2♀. WASHINGTON: Spirit Lake, July 20, 1947, C. P. Alexander, 1♂, 1♀. WYOMING: Same data as for holotype, 4♂.

Types in the collection of the Illinois Natural History Survey except the specimens from Spirit Lake, which are in the collection of D. G. Denning.

Rhyacophila alberta Banks

Rhyacophila alberta Banks, Bull. Mus. Comp. Zool. **62**: 21. 1918. ♂.

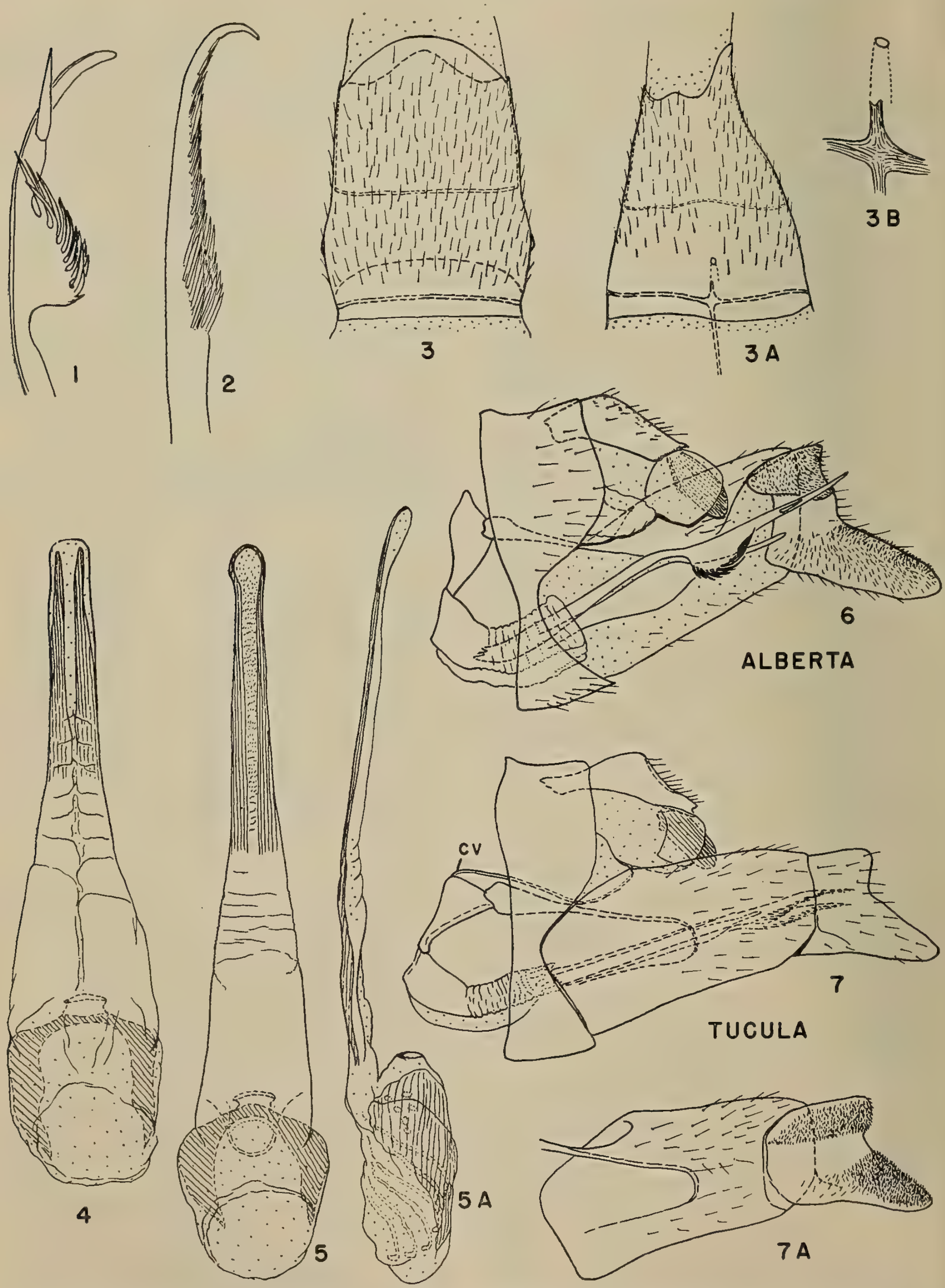
Rhyacophila mirus Denning, Psyche **55**: 21. 1948. ♂, ♀. New synonymy.

This species and *tucula* are very closely related. Figs. 1, 4, and 6 illustrate the diagnostic characters of the male genitalia and the female spermatheca. This latter structure differs from that of *tucula* chiefly in that the dorsal sclerotized bands do not reach the tip of the elongate apical portion.

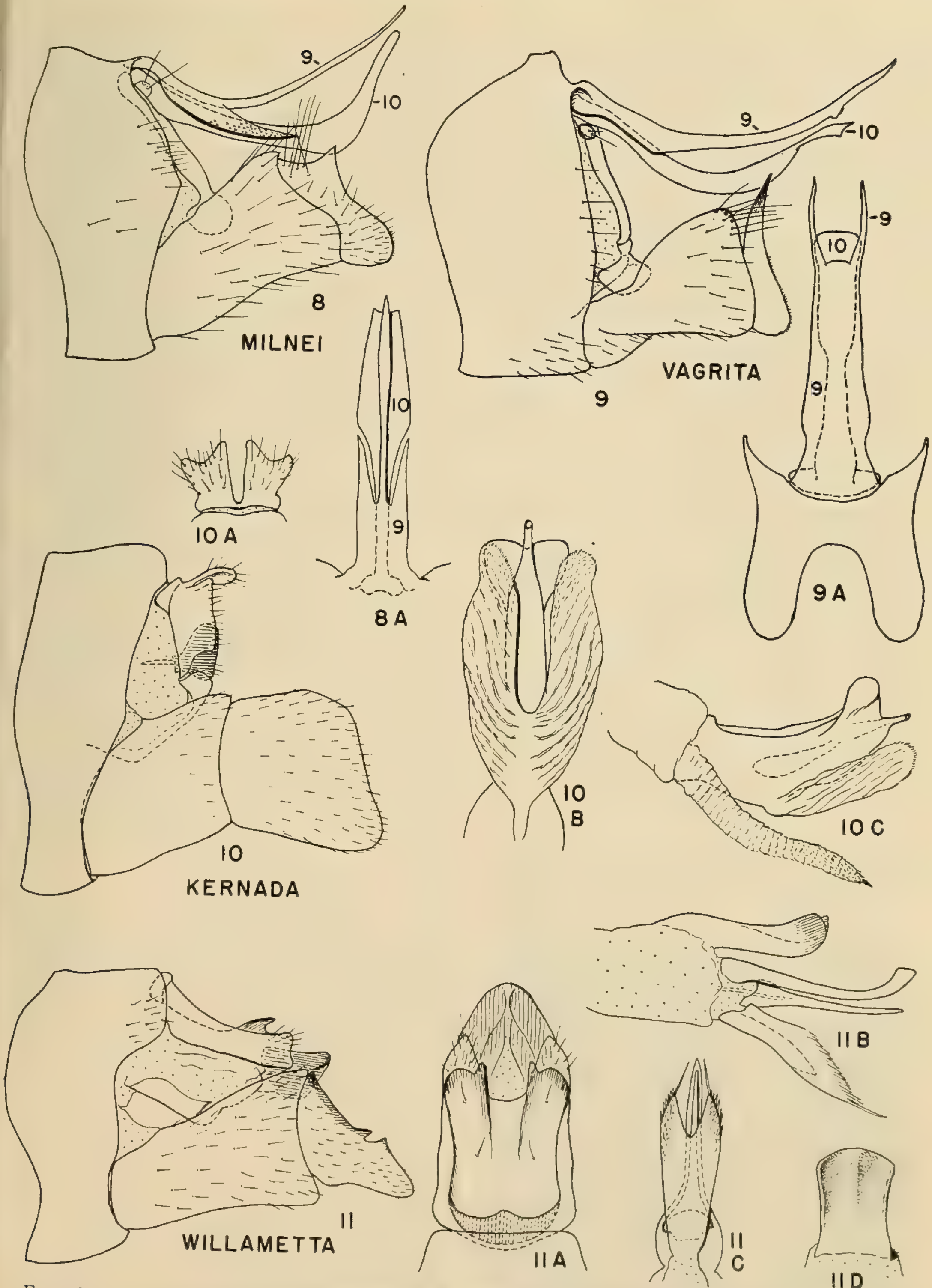
The ranges of *alberta* and *tucula* are very interesting. Records for *alberta* are available from Banff, Alberta (type of *alberta*); Tolland and Silverton, Colo.; Uintah Mountains, Utah; and Snowy Range Mountains, Albany County, Wyo. (type of *mirus*). Comparison of these localities with those for *tucula* indicates that *alberta* is apparently restricted to the eastern montane region of the West, whereas *tucula* appears to be the dominant species of the group in the western ranges. The ranges of the two species overlap, at least in Wyoming, and subsequent collecting may demonstrate that this occurs over a fairly wide area.

Rhyacophila willametta, n. sp.

This species is probably most closely related to *perda* Ross but differs markedly from it in the shape of every structure, especially the short,



Figs. 1-7.—Parts of *Rhyacophila*: 1, *R. alberta* Banks, apex of lateral arm of aedeagus; 2, *R. tucula*, n. sp., apex of lateral arm of aedeagus; 3, *R. tucula*, ventral aspect of eighth segment of female; 3A, same lateral aspect; 3B, detail of apodeme; 4, *R. alberta*, spermatheca, dorsal aspect; 5, *R. tucula*, spermatheca, dorsal aspect; 5A, lateral aspect; 6, *R. alberta*, male genitalia, lateral aspect; 7, *R. tucula*, male genitalia, lateral aspect; 7A, inner face of clasper.



Figs. 8–11.—Male genitalia of *Rhyacophila*: 8, *R. milnei*, n. sp., lateral aspect; 8A, eighth and ninth tergites, dorsal aspect; 9, *R. vagrita* Milne, lateral aspect; 9A, ninth and tenth tergites, dorsal aspect; 10, *R. kernada*, n. sp., lateral aspect; 10A, tenth tergite, dorsal aspect; 10B, same, main portion of aedeagus, ventral aspect; 10C, aedeagus, lateral aspect; 11, *R. willametta*, n. sp., lateral aspect; 11A tenth segment, dorsal aspect; 11B, aedeagus, lateral aspect; 11C, same, ventral aspect; 11D, same, dorsal aspect.

wide, dorsal process of the aedeagus and the declivous posterior margin of the apical segment of the clasper.

Male.—Length from front of head to tip of folded wings, 13 mm. Color of dorsum dark brown; appendages and venter yellowish brown; wings smoky brown with a few small lighter areas near the apex of the distal cells. General structure typical for genus. Genitalia as in Fig. 11. Ninth segment annular, the dorsal part longest, projecting beyond the remainder. Tenth tergite with dorsal and lateral lobes fused into a somewhat rectangular shelf, the dorsal lobe subdivided into a pair of lateral processes which project upward and posteriad; the lateral lobes are apparently fused with the dorsal lobe, each line of fusion appearing as a dorsal ridge; mesal lobes fused dorsad, the two halves separated ventrally by an elliptic opening. Clasper with basal segment elongate and becoming wider toward apex; apical segment fairly short, the dorsal margin declivous, this declivity ending in a short, sharp process which appears to represent the heel, beyond which is a moderate-sized, somewhat rounded toe.

Aedeagus (Fig. 11B, C, D) with four sets of processes: (1) A stout, heavily sclerotized, wide dorsal process excavated and carinate dorsad; (2) a single, broad, pointed, and upturned process below this; (3) below this a narrower, pointed process bearing the penis (these last two each with a bulbous base); and (4) a scooplike ventral process which bears a tight comb of thin spines along its lateral margin.

Holotype.—Male, Salt Creek Falls, Willamette Pass, Oreg., August 7, 1948, Kenneth M. Fender,

Paratype.—Male, Store Gulch Guard Station. Siskiyou Mountains, Oreg., August 9, 1948, Kenneth M. Fender. (Types in the collection of the Illinois Natural History Survey.)

Rhyacophila milnei, n. sp.

This species is a close relative of *vagrita* Milne, differing in having the apical segment of the clasper slightly longer and produced into only a short, broad point on the posterodorsal corner and in having the elongate projection of the ninth tergite trifid rather than bifid.

Male.—Length from front of head to tip of folded wings, 9 mm. Color light brown, the venter and appendages lighter, the wings very light brown and with only a faint indication of a pattern. General structure typical for genus. Male genitalia as in Fig. 8. Ninth segment annular, with a long mesal process arising from the posterior margin of the dorsum, this process trifid, consisting of a pair of lateral spiculate processes and a much longer, slender, fusiform mesal process. Tenth tergite with dorsal process very long and upturned, narrow at base and widened just beyond the middle to form a large spadelike apex from dorsal view; at the base of this process is the minute, knoblike cercus; from the dorsal lobe extends a straplike mesal arm ending in a bulbous apex flanked by a pair of small lateral flaps. Clasper with basal segment moderately long and deep, largest at apex; apical segment short and irregular, the heel forming a sharp, triangular point, the toe short, rounded, and bearing a moderately dense cushion of mesal spicules. Aedeagus simple, broad and flat, the extreme apex with a narrow, dorsal, beaklike process which curves ventrad; from the ventral margin there extends an ovate, membranous, tonguelike flap which extends slightly beyond the remainder of the aedeagus.

Holotype.—Male, Banff, Alberta, September 5, 1922, C. B. D. Garrett.

Paratypes.—Three males, same data as for holotype. (Types in the collection of the Illinois Natural History Survey.)

The four specimens listed above were originally designated as paratypes of *vagrita*. So great is the similarity of the two species, both in general appearance and structure of genitalia, that the existence of a second species in the series was not suspected until I cleared the genitalia of several specimens.

Rhyacophila kernada, n. sp.

This species is a very close relative of *coloradensis* Banks, differing from it in the extremely small incision, seen from lateral view, between the dorsal and lateral flaps of the lobes of the tenth tergite, and the completely membranous, spiculate, lateral arms of the aedeagus. In *coloradensis* a long portion of the apex of these lateral arms is sclerotized.

Male.—Length from front of head to tip of folded wings, 10 mm. Color dark brown above, lighter brown on the venter, the apices of the leg segments darker brown, the front tibia with a light band just beyond middle, the hind legs in general almost straw-color and contrasting with the light brown of the front and middle legs. Wings with irregular irrorate pattern, with a lighter and somewhat bandlike area on the anterior portion basad of the stigma. General structure typical for genus. Genitalia as in Fig. 10. Ninth segment annular, the dorsum higher than the tenth tergite, and with a steep apical declivity. Tenth tergite composed of (1) a dorsal pair of earlike lobes, each with a small dorsal and deep lateral flap, (2) a mesal pair of heavily sclerotized, closely appressed sclerites appearing bulbous from lateral view and together circular from posterior view, (3) a very small, ovate sclerite with a short, sclerotized, mesal apodeme, this sclerite situated between the preceding two, and (4) a pair of small ventral lobes which unite below this entire structure and articulate with the dorsum of the aedeagus. Clasper with both segments about equal in length, depth, and area, both rhomboidal, the apical segment slightly incised at apex with the apical third of the mesal aspect covered with small black spicules. Aedeagus beyond basal tube consisting of a central sclerotized portion which at the apex has a pair of lateral knobs and a single slender, mesal, beaklike projection; arising from the base of this structure a large U-shaped semimembranous flap; and, arising at the base, a pair of membranous extensile arms, the apical third clothed with dense, pale spicules, the extreme tip with a single sharp spine.

Holotype.—Male, Kern River, Road's End, Calif., September 25, 1940, at light. Deposited in the United States National Museum.

MALACOLOGY.—*A new terrestrial mollusk from Mexico.*[1] Paul Bartsch, U. S. National Museum.

The new species of gastropod described below, belonging to the genus *Coelostemma* Dall, is based on specimens collected about 29 miles west of Jiménez, Chihuahua, Mexico, and presented to the U. S. National Museum by George F. Freytag, of the Missouri Botanical Garden. Mr. Freytag states that while collecting in the Chihuahuan desert he came upon this snail and brought back about a dozen examples. He says: "They seem to be night travelers and attach themselves during the day by sealing their shell openings to the cliff."

Coelostemma freytagi, n. sp.

Shell elongate-conic, pale horn-colored, with the peristome almost white. The nucleus consists of about 2¼ turns, which are inflated and strongly rounded and form a bulbous apex. The nuclear whorls are finely granulose. The first eight postnuclear whorls increase gradually in size; the rest form a cylindric spire, which becomes very slightly contracted toward the base. All the postnuclear turns are crossed by strong, sublamellar, hollow, retractively curved axial ribs, which extend equally strong from the summit of the periphery. The ribs are separated by spaces that are not quite constant in width but average about 1½ times as wide as the ribs. On the first postnuclear whorls the ribs are feeble, but on the second turn 20 strong ribs are present. On the tenth turn there are 26, while the last whorl bears 16 plus a few wrinkles immediately adjoining the peristome. Suture moderately impressed, rendered slightly sinuous by the axial ribs. Last whorl solute for about one-tenth of a turn. Periphery slightly angulated. Base short, well rounded, and crossed by the axial ribs, which extend slightly diminished to the umbilical chink. Aperture subcircular. Peristome broadly flatly expanded. The columella is very broad, about one-third the width of the inside of the whorls; it is smooth and glistening and shows faint axial markings.

The holotype, U.S.N.M. no. 601851, has 18 whorls, and measures: Length, 18 mm; diameter of middle turns, 4 mm. Five paratypes are listed as U.S.N.M. no. 601852.

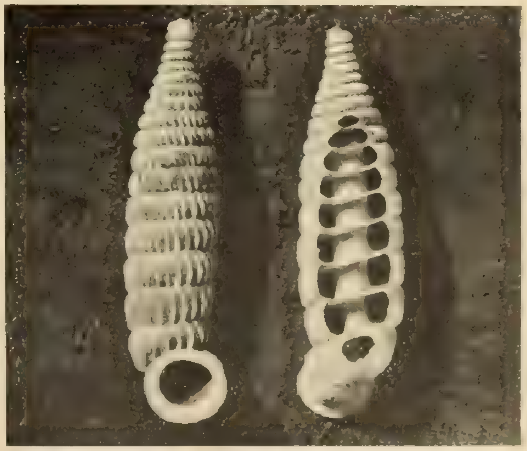


Fig. 1.—*Coelostemma freytagi*, n. sp.

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[1] Received May 8, 1950.

ICHTHYOLOGY.—*Notes on the blennioid fish genera* Runula (*subfamily Petroscirtinae*) *and* Tripterygion *and* Helcogramma (*family Clinidae*), *of the American tropical Pacific.*[1] LEONARD P. SCHULTZ, U. S. National Museum.

During my recent studies of the blennies of the Marshall Islands, it was necessary to examine some of the American species in the subfamilies Petroscirtinae and Clinidae. The following notes should help clarify the species and nomenclatorial status of several genera and species of American blennies.

PETROSCIRTINAE

The family Atopoclinidae is listed in Jordan, Evermann, and Clark's *Check list of the fishes and fishlike vertebrates of North and Middle America. . .* (Rep. U. S. Comm. Fish 1928, pt. **2:** 465. 1930). Norman (Ann. Mag. Nat. Hist. (2) **10:** 793. 1933) referred the genus *Atopoclinus* Vaillant with uncertainty to the blennioid genus *Aspidontus* Quoy and Gaimard. My study of the genotypes of *Aspidontus* and of *Runula* revealed that there were two groups of species representing two different phylogenetic lines and that all the American Pacific species belonged to the *Runula* group including *Atopoclinus*. After carefully studying all the material in the U. S. National Museum referable to the two genera mentioned, it was concluded that *Runula* was distinct and should be removed from the synonymy of *Aspidontus* as defined by Norman, 1943, on the basis of the following characters:

1*a*. Pectoral rays usually 14; incisorlike teeth of lower jaw approximately equal in number and in size to those of upper jaw. *Aspidontus*
1*b*. Pectoral rays usually 12; incisorlike teeth of lower jaw notably twice or nearly twice as numerous and about half as wide as those in upper jaw. . . . . *Runula*

Genus **Runula** Jordan and Bollman

Runula Jordan and Bollman, Proc. U. S. Nat. Mus. **12**: 171. 1890 (genotype, *Runula azalea* Jordan and Bollman).
Atopoclinus Vaillant, Bull. Soc. Philomat. Paris (3) **6**: 73. 1890 (genotype, *Atopoclinus ringens* Vaillant).

So far in the tropical American Pacific but two species of *Runula* have been found. They may be distinguished by the following key, aided by table 1:

TABLE 1.—COUNTS MADE ON CERTAIN SPECIES OF RUNULA

Species	Number of fin rays														
	Dorsal								Anal					Pectoral	
	VII	VIII	IX	31	32	33	34	35	II	27	28	29	30	12	13
ringens . .	1	4	1	1	1	1	1	2	5	2	2	1	—	3	1
azalea . . .	1	5	—	1	—	1	3	1	5	—	1	3	1	8	—

Species	Number of incisorlike teeth													
	Lower jaw								Upper jaw					
	41 42	43 44	45 45	47 48	49 50	51 52	53 54	55 56	21 22	23 24	25 26	27 28	29 30	31 32
ringens	—	—	—	—	—	—	2	1	—	—	1	—	—	2
azalea	1	2	1	—	1	—	—	—	1	2	—	—	—	—

1*a*. Sides with a dark brown band, usually broken into more or less distinct small blotches posteriorly, then continuing on caudal fin, tapering to a point at rear end of middle rays of caudal fin; dorsal fin with a median black band, white-edged distally, and basally pale. . . . . *R. ringens* (Vaillant)
1*b*. Dark lateral band if present usually indistinct, not continuing to rear of caudal fin but ending in a small dark spot basally; sides and especially dorsal fin, with 6 dark bars; anal with 4 dark bars; no dark band in dorsal fin. *R. azalea* Jordan and Bollman

The nomenclature for the two species follows:

Runula ringens (Vaillant)

Atopoclinus ringens Vaillant, Bull. Soc. Philom. Paris (3) **6**: 74. 1890 (type locality, Gulf of California).
Runula albolinea Nichols, Zoologica **5** (4): 64, fig. 11. 1924 (type locality, Galápagos Islands).
Petroscirtes panamensis Fowler, Acad. Nat. Sci. Philadelphia Monogr. **6**: 291, fig. 246. 1944 (Pearl Islands).

Runula azalea Jordan and Bollman

Runula azalea Jordan and Bollman, Proc. U. S. Nat. Mus. **12**: 171. 1890 (type locality, Galápagos Islands).
Petroscirtes belanskei Borodin, Bull. Vanderbilt Oceanogr. Mus. **1** (1): 33, pl. 3, fig. 3. 1928 (type locality, Costa Rica).

I have compared the figure of *P. belanskei* with the holotype of *R. azalea*, U.S.N.M. no. 44299, and have no doubt that it is the same species as *azalea*.

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[1] Published with permission of the Secretary of the Smithsonian Institution. Received May 8, 1950.

Clinidae

My study of the numerous species of the world centering around the genera *Tripterygion*, *Enneapterygius*, and *Enneanectes* of authors indicated much confusion in regard to both genera and species. I did not find a review of the genera or of some 49 species already named for this group of fishes. Therefore, in order to come to some conclusion as to what genus to refer certain species that I was studying in the Marshall Island material, it was necessary to survey all the genotypes so far proposed. The following key though tentative is intended to help define the genera as observed by me in the literature:

1a. First dorsal with III to VII spines, notably separated from second spiny dorsal fin, or membrane incised to base forming 2 distinct spiny dorsal fins.

2a. First dorsal fin with V to VII spines, second dorsal with about XIX to XXII spines; anal with about II, 25 to 27; pectoral rays about 17 to 19; vertical scale rows about 60 to 65; lateral line, anteriorly, separated from base of second spiny dorsal by 5 or 6 scales; breast scaly; head naked.

Forsterygion Whitley and Phillipps[2]

2b. First dorsal fin with III or IV spines; second with X to XVII; dorsal soft rays 6 to 15; anal I or II, 13 to 26; scales in about 20 to 45 vertical rows.

3a. Lateral line represented by pores anteriorly, and convexly curved above pectoral fin, separated by 2 to 5 scales from base of spiny dorsal fins, and ending from opposite base of second dorsal to that of front of base of soft dorsal, thence commencing 1 or 2 scales below and continuing as notched scales along midlengthwise axis of body.

4a. Pectoral rays 14 to 16; 2 or 3 scales between anterior lateral line and base of second dorsal; first dorsal usually with III spines, rarely IV.

Tripterygion Risso

4b. Pectoral rays usually 11; 4 or 5 scales between anterior lateral line and base of second dorsal; dorsal rays IV-X-12 or 13; anal I, 22 or 23; lateral-line pores 15 + 25......*Notoclinus* Gill[3]

3b. Lateral line concavely curved downward behind pectoral fin, separated by 4 to 8 scales from base of second spiny dorsal fin, thence continuing along midlengthwise axis of body, the last scales sometimes notched posteriorly.

Helcogramma McCulloch and Waite

1b. First dorsal of III or IV spines, separated from following spines by a notably wider than usual space, but membrane continuous, forming a single spiny dorsal fin; no cirri on eye or on nape; dorsal rays about III, XIV-12; anal II, 17; head naked, about 7 scales in a row from lateral line and middle of base of spiny dorsal; lateral line curving downward behind pectoral fin, thence extending along midlengthwise axis of body.

Lepidoblennius Steindachner[4]

As a result of the generic analyses of various species of the fishes in this relationship, it was observed that the American species were little understood and were greatly confused. In order to clarify the status of the genus *Enneanectes*, all the American species were compared. I am grateful to J. Bökle, for data supplied on specimens in the Stanford Museum collections, especially for the holotype of *E. storeyae* Brock. The following analysis of America genera and species, it is hoped, will aid those who may wish to identify species in the genera *Tripterygion* and *Helcogramma:*

1a. Lateral line represented by pores anteriorly and convexly curved above pectoral fin, separated by 2 to 4 scales from base of second spiny dorsal fin, and ending from opposite base of second dorsal to front of base of soft or third dorsal, thence commencing 1 or 2 scales below and continuing as posteriorly notched scales, along midlengthwise axis of body (*Tripterygion*).

2a. Dorsal rays about III–XIII to XV-13 or 14; anal II, 21; pectoral 17 or 18; pores in lateral line 27 + 12; about 3 or 4 scales above lateral line to base of second dorsal and at beginning of posterior lateral line about 3 scales to base of anal fin; head with scales, breast partly scaled; about 14 scales in a zigzag row around caudal peduncle.

Tripterygion corallicola (Kendall and Radcliffe)

2b. Dorsal rays about III–X to XIII-6 to 8; pectoral usually 15; about 2 scales above dorsal lateral line and base of second dorsal and 2 or 3 scales between posterior lateral line and anal-fin base; zigzag scales around caudal peduncle 8 or 9.

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[2] *Forsterygion* Whitley and Phillipps, Trans. Roy. Soc. New Zealand **69** (2): 236. 1939 (genotype, *Blennius varius* Bloch and Schneider = *Tripterygion nigripenne* Cuvier and Valenciennes), probably = *Tripterygion capito* Jenyns, Zoology voyage *Beagle*, pt. 4, Fish: 94–95, pl. 19, fig. 1. 1842 (Bay of Islands, New Zealand).

[3] *Notoclinus* Gill, Mem. Nat. Acad. Sci. **6**: 95, 124. 1893 (genotype, *Tripterygion fenestratum* = *Blennius fenestratus* Bloch and Schneider). Gill based the genus *Notoclinus* on a large specimen of *fenestratum* from New Zealand (U.S.N.M. No. 39672); it measures 180 mm. in standard length.

[4] *Lepidoblennius* Steindachner, Sitzb. Akad. Wiss. Wien **55**: 3. 1867 (genotype, *Lepidoblennius haplodactylus* Steindachner).

3*a*. Area in front of anal fin usually completely or partly scaled; normally a few scales on head of adults; dorsay rays III–XI or XII-6 or 7; anal usually I, 16; pores in lateral lines about 13 + 17 to 19.

Tripterygion jordani (Evermann and Marsh)

3*b*. Area in front of anal fin naked; head naked; dorsal rays usually about III-X-8, anal probably about I, 16; pores in lateral line 10 + 21.

Tripterygion sexmaculatus Fowler

1*b*. Lateral line concavely curved downward behind pectoral fin and continuing along midlengthwise axis of body, separated by 4 to 8 scales from base of second spiny dorsal fin, and 4 to 8 scales from anal origin (*Helcogramma*); dorsal rays III–XI or XII-9 or 10; anal II, 16 or 17; pectoral 15 or 16; about 30 to 34 pores in lateral line, 4 or 5 scales between lateral line and base of second dorsal, and about 4 scales between lateral line and anal fin base; head and breast naked; 12 to 15 scales in a zigzag row around caudal peduncle.

Helcogramma carminale (Jordan and Gilbert)

The synonymy of various genera and species follows:

Genus **Tripterygion** Risso

Tripterygion Risso, Hist. Nat. Eur. Merid. **3:** 241. 1826 (genotype, *Tripterygion nasus* Risso); sometimes amended to *Tripterygium* of authors.

Enneapterygius Rüppell, Neue Wirbeth. Abyssinia, Fische: 2. 1835 (genotype, *Enneapterygius pusillus* Rüppell).

Enneanectes Jordan and Evermann, *in* Jordan, Proc. California Acad. Sci. (2) **5:** 501, pl. 53. 1895 (genotype, based on pl. 53, "*Enneanectes carminalis*" not of Jordan and Gilbert = *Gillias sexmaculatus* Fowler, 1941). *Tripterygium carminale* Jordan and Gilbert, holotype U.S.N.M. no. 120946, was found by me with the types of *Gobiesox zebra* in 1944 and belongs to another genus (see *Helcogramma*) as indicated in this study.

Gillias Evermann and Marsh, Rep. U. S. Fish Comm. **25** (1899): 357. 1900 (genotype, *Gillias jordani* Evermann and Marsh).

Trianectes McCulloch and Waite, Rec. South Austr. Mus. **1** (1): 53. 1918 (genotype, *Trianectes bucephalus* McCulloch and Waite).

Notoclinops Whitley, Mem. Queensland Mus. **10:** (1) 20. 1930 (genotype, *Tripterygion segmentatum* McCulloch and Phillips).

Verconectes Whitley, Austr. Zool. **6** (1): 324. 1931 (genotype *Tripterygion bucephalus* McCulloch and Waite; proposed to replace *Trianectes*, said erroneously by Whitley to be preoccupied).

Vauclusella Whitley, Austr. Zool. **6** (4): 324. 1931 (genotype, *Tripterygion annulatum* Ramsey and Ogilby).

Tripterygion corallicola (Kendall and Radcliffe)

Enneapterygius corallicola Kendall and Radcliffe, Mem. Mus. Comp. Zool. **35** (3): 153, pl. 7, fig. 1. 1912 (type locality, Chatham Island, Galápagos; holotype, U.S.N.M. no. 65484).

Tripterygion jordani (Evermann and Marsh)

Gillias jordani Evermann and Marsh, Rep. U. S. Fish Comm. **25** (1899): 357. 1900 (type locality, Puerto Rico; holotype, U.S.N.M. no. 49368; paratypes, U.S.N.M. no. 126096).

Enneapterygius pectoralis Fowler, Proc. Acad. Nat. Sci. Philadelphia. **93:** 96, figs. 10–12. 1941 (type locality, Sanibel Island, Fla.).

Tripterygion sexmaculatus (Fowler)

Enneanectes carminalis (not Jordan and Gilbert) Jordan, Proc. California Acad. Sci. (2) **5:** 501, pl. 53. 1895 (Mazatlán) Stanford Univ. no. 3854. Brock, *l,c.*).

Gillias sexmaculatus Fowler, Acad. Nat. Sci. Philadelphia Monogr. 6: 286, fig. 241. 1941 (type locality, Pearl Islands, Panama).

Genus **Helcogramma** McCulloch and Waite

Helcogramma McCulloch and Waite, Rec. South Austr. Mus. **1:** 51. 1918 (genotype, *Helcogramma decurrens* McCulloch and Waite).

Axoclinus Fowler, Acad. Nat. Sci. Philadelphia Monogr. 6: 288. 1941 (genotype, *Axoclinus lucillae* Fowler = *Tripterygium carminale* Jordan and Gilbert, holotype U.S.N.M. no. 120946, found by Schultz with the types of *Gobiesox zebra* and not lost as published by Fowler (ibid.) and by Brock (Stanford Univ. Bull. **2** (1). 1940); Fowler's misspelling on p. 388, fig. 242, *Axochnus*, a typographical error.

Helcogramma carminale (Jordan and Gilbert)

Tripterygium carminale Jordan and Gilbert, Proc. U. S. Nat. Mus. **4:** 362. 1882 (type locality, Mazatlán; holotype, U.S.N.M. no. 120946).

Enneapterygius storeyae Brock, Stanford Ichth. Bull. **2** (1): 33. 1940 (type locality, Cape San Lucas; holotype, S.U. no. 35045).

Axoclinus lucillae Fowler, Acad. Nat. Sci. Philadelphia Monogr. 6: 289, fig. 242. 1941 (type locality, Pearl Islands, Panama).

The "neotype" Stanford University no. 3854 by Brock, 1940, does not belong to this genus and species but is a specimen of *Tripterygion sexmaculatus* (Fowler).

ICHTHYOLOGY.—Ichthyocampus pawneei, *a new pipefish from the Bahamas.*[1]

Earl S. Herald, Steinhart Aquarium, California Academy of Sciences. (Communicated by L. P. Schultz.)

In the syngnathid section of the forthcoming Bikini report, the writer presents a partial treatment of the 15 species in the genus *Ichthyocampus*. Fourteen of these, including two that are new, are limited to the Indo-Pacific region. The fifteenth member is also new and is the only species of the genus to occur in the Atlantic. It is described in this preliminary paper in order to avoid description in the Bikini report, which deals primarily with Central Pacific fishes.

Ichthyocampus pawneei, n. sp.

Holotype.—Bingham Oceanogr. Coll. no. 3327, 22 mm, juvenile, taken at Guen Cay, Bahamas, by the *Pawnee*, station 6, surface, February 27, 1927.

Diagnosis.—Dorsal fin rays 26; pectoral 10–11 (?); anal 0; caudal 8 (?); dorsal fin covering 1 trunk ring and 9½ tail rings; trunk rings 17; tail rings 32; head in standard length 7.6; dorsal in head 0.72; snout in head 3.22; lateral trunk ridge continuous with inferior tail ridge; superior trunk and tail ridges continuous; inferior trunk and tail ridges discontinuous; and lateral tail ridge absent, as is characteristic of *Ichthyocampus*.

Description.—The top of the very short snout is raised to a dulled ridge and forms a distinct hump between the maxillary and interorbital area. At the interorbital area the snout ridge branches and is continuous with the markedly elevated anterior supraorbital ridges, and thus a conspicuous Y is formed by these three structures. Prenuchal and nuchal ridges are barely visible, and the opercular ridge extends faintly for about one-half of the length of the opercle. All other head ridges are absent, including the posterior supraorbitals as well as those usually found on the pectoral cover plate. The trunk and tail ridges are slightly raised, but the body angles are distinct and are not rounded. The scutella are quite large and in width are equal to the distance between the nearest edges of the adjacent scutella, or to 1½ times that distance. The pectoral fins are very small and are equal in length to approximately the width of a single trunk ring. No cirri are present.

This species is named in honor of the collecting ship, the *Pawnee*.

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[1] Received May 8, 1950.

MAMMALOGY.—*Validity of the subspecies* Enhydra lutris nereis, *the southern sea otter.*[1]

Victor B. Scheffer and Ford Wilke, U. S. Fish and Wildlife Service. (Communicated by Herbert Friedmann.)

The sea otter at one time occupied the rim of the northern Pacific Ocean and the southern Bering Sea from the islands of Guadalupe and Natividad, Lower California, to the Pribilof Islands, Alaska, and Hokkaido, Japan. It is now restricted to southern California (several hundred animals), British Columbia (occurrence doubtful), continental Alaska (several hundred), the Aleutian Islands (several thousand), the Commander Islands (perhaps a thousand), and the Kurile Islands (several hundred to several thousand). The former range of the sea otter was, with the exception of a 200-mile gap of open water between Attu and Copper islands, a continuous sweep.

In 1904, C. Hart Merriam described the sea otter of southern California as a "well-marked subspecies," *Latax lutris nereis*, on the basis of a single skull from the Channel Islands (Proc. Biol. Soc. Washington **17:** 159). In 1930, Joseph Grinnell compared the type of *nereis* with "an example . . . of the same sex and age" from the Aleutian Islands and found differences that led him to regard the southern subspecies as valid (*Fur-bearing mammals of California*: 287. 1937). We have reexamined the specimens used by Merriam and Grinnell and have compared them with material from Alaska, Washington, Oregon, and California. Our total collection includes 56 adult skulls.

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[1] Received May 3, 1950.

SKULL CHARACTERS

The diagnostic features of *nereis* as set forth by Merriam, followed by our own comments, are given below.

1. "Skull large, broad, and high, with long and high sagittal crest and swollen braincase." We find, however, that southern specimens tend to be slightly *smaller* than northern ones:

CONDYLOBASAL LENGTH IN MILLIMETERS

Locality	Males			Females		
	N	Mean	Range	N	Mean	Range
Western Alaska.......	8	140	130–145	3	131	131–131
Washington and Oregon................	2	135	133–137[1]	2	129	126–133[2]

[1] Including the type of *nereis*, condylobasal length 133 mm.

[2] Including a very old animal (A.M.N.H. No. 28226), which is certainly a female, although the sex is not recorded.

Grinnell, too, states that "the general size of the type of *E. l. nereis* is decidedly smaller [than an Aleutian skull of comparable age] and the brain case is relatively higher" (*op. cit.*: 287–288). Grinnell's analysis of the difference between two adult male skulls, one the type of *nereis* (U.S.N.M. no. 133508) and one from Kiska, Alaska (U.S.N.M. no. 13222), is good. Perhaps inadvertently, though, he selected as a typical Alaskan skull an extremely large one. Out of 43 skulls of adult male, and sex-unknown, sea otters from Alaska, specimen no. 13222 is exceeded in size by only one.

We find that southern sea-otter skulls (with the exception of Merriam's type) are no higher than northern ones. The height measurement is a difficult one to take and is unsatisfactory because of irregularities on the skull.

2. "Anterior part of zygomata more broadly and squarely expanded." We are unable to see a consistent difference between northern and southern skulls.

3. "Basioccipital forming an angle with basisphenoid." The meaning of this statement is not clear. Perhaps Merriam meant the angle formed by the planes of the two bones. In subadult northern as well as southern skulls, the plane of one bone usually forms an angle with the plane of the other. After the suture has knit, the angle or convexity tends to disappear, and the two bones to align themselves in the same plane.

4. "Coronoid processes sloping strongly backward." We have sketched the left process in six adult skulls of similar size (Fig. 1). One California specimen (Fig. 1, *a*) shows a definite backward slope; another (Fig. 1, *d*) does not.

5. "Sagittal crest much higher and more decurved posteriorly." The height of the sagittal crest is a poor diagnostic character because it varies so greatly with age and because it is difficult to measure. The evidence offered by the crest is thus inconclusive.

Locality	Males		Females	
	Condylobasal length	Height of sagittal crest	Condylobasal length	Height of sagittal crest
Western Alaska..........	140[1]	7.6[1]	133[2]	5
			131	5
			131	6
			131	4
Oregon and California...	137	3	133[2]	9
			127	4

[1] Mean of 7 specimens, CBL 139–142; HSC 7–8.

[2] Quite certainly a female.

6. "Inner cusp of large upper premolar (*pm 3*) elongated along anterior part of inner lobe (instead of conical) and showing a tendency to subdivide into two parts." This is a peculiarity of the type specimen. Merriam's "*pm 3*" is presumably Miss Fisher's "*PM 4*" (Journ. Mamm. **22**: 429. 1941).

7. "1st lower molar broader and more broadly truncate posteriorly." We are unable to see these differences. Grinnell suggests as a diagnostic

Locality	Males		Females	
	Condylobasal length	Width of molar	Condylobasal length	Width of molar
FIRST LOWER MOLAR				
Western Alaska..........	140[1]	13.0[1]	131	13.0
			131	12.8
			131	12.7
Oregon and California...	137	13.1	133[2]	13.0
			127	13.0
LAST UPPER MOLAR				
Western Alaska..........	139[3]	20.3[3]	131	19.3
			131	19.1
			133[4]	20.9
Oregon and California...	137	20.0	133[2]	20.6
	133	21.0	126	18.5

[1] Mean of 7 specimens, CBL 139–142 and WM 12.6–13.8.

[2] Quite certainly a female.

[3] Mean of 7 specimens, CBL 130–142 and WM 19.7–21.1.

[4] The type of *nereis*.

feature of the southern sea otter the greater width of the last upper molar. In 14 specimens available to us, however, this is not demonstrable. Regardless of sex or locality, the fully adult upper molar is about 20–21 mm. in diameter.

BODY LENGTH

Merriam states that the type "specimen in the flesh measured 6 feet in length." This is unquestionably an error. Stephens (*California mammals*: 233. 1906) describes the size of the California sea otter as "length about 1200 mm (48 inches)." Miss Fisher (California Fish and Game **26:** 281. 1940) gives the size of two subadult males from California as: Length in millimeters, 1,313 and 1,270 [inches, 51.7 and 50]; weight in pounds, 65 and 63. To the best of our knowledge, the largest Aleutian sea otter on record, a male we collected in 1947, had a length of 58 inches. Since there appear to be no authentic measurements of an adult sea otter from the California, Oregon, or Washington coasts, it is impossible at the present time to compare the sizes of northern and southern animals.

PELAGE

Merriam did not mention pelage in his description of *nereis*, since he had only a skeleton to work with. Chase Littlejohn, who formerly hunted sea otters in Alaska and California, says that on the southern animal "the fur is just as pretty but shorter" (*fide* Hall, in Journ. Mamm. **26:** 91. 1945). From Stevenson (Rep. U. S. Comm. Fish and Fisheries for 1902: 321. 1904) we quote, as follows:

> The color of the pelt varies considerably, the predominant shade being lustrous brown brightened with silvery overhairs. Some pelts are a deep brown or a brownish black, and are known in the trade as 'black.' Others are brown, with a tendency toward bluish green or dark-plum color, and are known as 'dark.' The fur is in all cases lighter on the abdomen than on the back. The hair on the head is lighter in color, and is light brown in the brown variety, but in the black animals it is almost completely white, the effect of the large number of white overhairs. The skins from British Columbia, Washington, and Oregon are frequently of a yellowish-brown hue, and albino skins have been taken rarely.

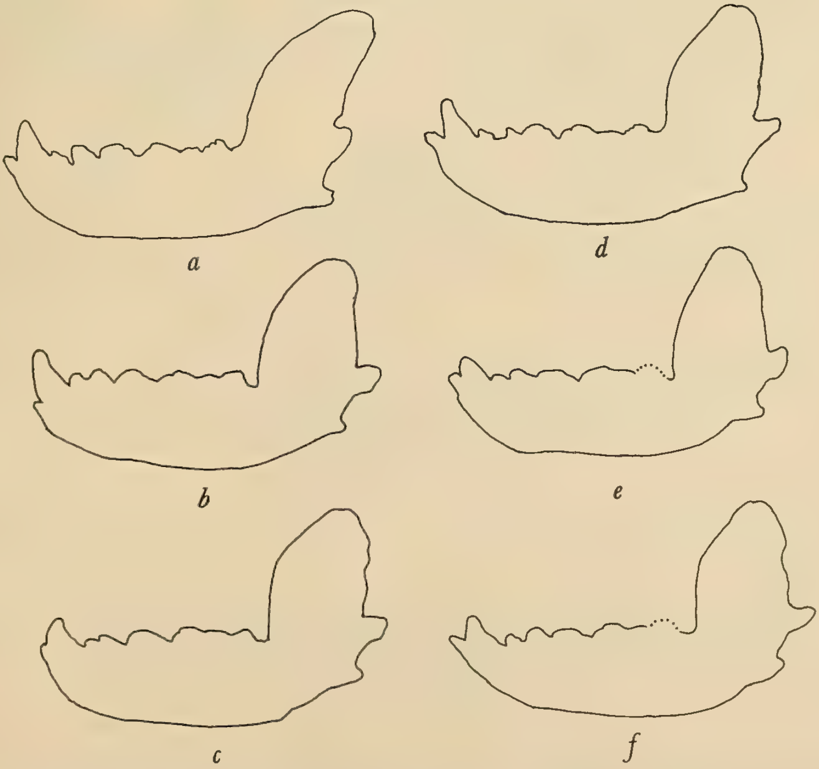

FIG. 1.—Left coronoid processes in six adult sea otters: *a*, California male, C.M.V.Z. no. 84812; *b*, Alaska male, ECH 95; *c*, Alaska male, ECH 21–48; *d*, California (female?), A.M.N.H. no. 28226; *e*, Alaska female, ECH 34; *f*, Alaska (female?), ECH 20–48.

Here is evidence of a color difference between sea otters inhabiting northern and southern waters. Whether it is valid throughout the seasons of the year we can not say. (In the Alaska fur seal, pelagic specimens taken in winter and spring are consistently grayer than those taken in summer, which are browner.)

CONCLUSIONS

In sea otters from California and Oregon the skull size is slightly smaller, and the coronoid processes may perhaps slope more strongly backward, than in sea otters from western Alaska. We have for study, however, only eight adult skulls from the southern region, three of them known-sex and five unknown. For lack of measurements, body size in northern and southern animals can not be compared at the present time. There is testimony that the pelage of sea otters inhabiting the warmer waters is relatively shorter and more yellowish. Some of the features described by Merriam in 1904 as diagnostic of the subspecies *nereis* are applicable to the type specimen alone, while others are applicable to northern as well as southern individuals. Though there may be a north-south gradient in certain features, we suspect that it is a smooth and uninterrupted one. Were we handed a skull from an unknown source we could not, with confidence, assign it to its proper locale. Neither on the basis of demonstrable variation nor on the grounds of geographical isolation is there support for a southern subspecies of the sea otter.

SPECIMENS EXAMINED

Fifty-six adult skulls, that is, with basioccipital-basisphenoid suture closed: CALIFORNIA, 5 (1 male, U.S.N.M.; 1 male, C.M.V.Z.; 2 sex-unknown, U.S.N.M.; 1 sex-unknown, A.M.N.H. OREGON, 2 (1 female, U.S.N.M.; 1 sex-unknown, U.S.N.M.). WASHINGTON, 1 (1 sex-unknown, U.S.N.M.). SOUTHEASTERN ALASKA, 2(1 sex-unknown, U.S.N.M.; 1 sex-unknown, C.M.V.Z.). WESTERN ALASKA, 46 (9 males, 3 females, 34 sex-unknown, U.S.N.M.).

ACKNOWLEDGMENTS

For assistance in this study we are deeply indebted to Elmer C. Hanson, who provided a large collection of skulls from the beaches of Amchitka Island; to Seth B. Benson, California Museum of Vertebrate Zoology; Harold E. Anthony, American Museum of Natural History, and David H. Johnson, U. S. National Museum.

Obituary

CARLOS DE LA TORRE.—On February 19, 1950, at his home in Havana, Cuba, Don Carlos de la Torre y Huerta, an honorary member of the Washington Academy of Sciences, terminated his mundane career, a victim of America's foremost malady, cancer.

Some achieve greatness in the field of science, education, government, or politics, but it is rarely that one finds all these qualities combined in one individual, as was the case in Don Carlos—Cuba's grand great man.

He was born on May 15, 1858, in Matanzas, where he received his early education in his father's colegio. He continued his studies at the Royal University of Havana, where he received the degree of "bachiller de artes." He next went to Spain, where he enrolled at the University of Madrid and achieved the degree of doctor en ciencas naturales on November 1, 1883. Returning to Cuba, he again became affiliated with the university, which later, after Cuba had achieved its independence, abbreviated its title to "University of Havana." Here he enrolled for the degrees of doctor of medicine and pharmacy, while occupying an assistantship. From this he advanced steadily to professorship, deanship, and finally to the presidency of the university—a most conspicuous, able, and beloved figure in each post. His many contributions and textbooks to Cuba's graded schools carried his name to every household in the island.

In government he served his country on various important committees as well as mayor of the City of Havana; also as a representative of his government to various congresses in America and Europe.

In the field of science he was Cuba's most outstanding figure. His many contributions to malacology, his major but by no means only field of endeavor, have received world-wide recognition.

Don Carlos was the recipient of many honors bestowed upon him by educational and scientific institutions in Europe and America. Harvard University bestowed upon him, honoris causa, the degree of doctor of science.

As a person, we may say of him that he was frank, fearless, able, helpful, and lovable—a man who made friends wherever he went, whose genial presence will be missed by all who knew him.

PAUL BARTSCH.

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JOURNAL
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VOLUME 40 SEPTEMBER 15, 1950 No. 9

PALEONTOLOGY.—*New genera of American Middle Ordovician "Cystoidea."*[1]

RAY S. BASSLER, U. S. National Museum.

Extinct primitive pelmatozoan echinoderms known as "Cystoidea" are so well represented in the national collections that I have been able to complete a considerable manuscript on the Ordovician species alone. As some time must elapse before publication of this can be expected, it was thought wise to describe and illustrate the new families and genera in advance, especially since they will thus be available for consideration in the treatise on invertebrate paleontology now in course of preparation under the auspices of the Geological Society of America, the Paleontographical Society, the Paleontological Society, and the Society of Economic Geologists and Paleontologists. In naming the new forms I have been guided by my feeling that as a part of its history any special and rare group of organisms like the present one should have its distinguished students represented by generic names in their honor.

Subphyllum PELMATOZOA Leuckart, 1848

Class EOCRINOIDEA Jaekel, 1915

SPRINGEROCYSTIDAE, n. fam.

Eocrinoidea in which the top of the theca is tubelike (*Springerocystis*) but may also be platform-shaped (*Columbocystis*) or consist of five broad, short, recumbent arms (*Foerstecystis*).

Springerocystis, n. gen.

Top of theca elevated into a short, tubelike, oral protuberance, with its upper margin formed by five thin oral plates arranged in a small circle. Named in honor of Dr. Frank Springer.

Genotype, *S. longicollis*, n. sp.

Springerocystis longicollis, n. sp. Fig. 3

Theca elliptico-fusiform in outline below, terminating in an acute base of 2 mm and narrowing toward the top into an oral protuberance. Height 28 mm, greatest width 20 mm, anal area about 2.5 mm in diameter with its center 8 mm below top of oral protuberance.

Occurrence.—Blackriveran (Benbolt formation), Knoxville, Tenn.

Cotypes.—U. S. N. M. no. 93397.

Columbocystis, n. gen.

Summit of theca supports a flat platform composed of five thick, wedge-shaped, oral plates centering about a small oral aperture from which diverge one anterior and two lateral narrow food grooves, the lateral ones branching within 1 mm. The food grooves terminate in five facets on the lateral sides of the platform to which the brachioles were attached and curving upward became erect.

Genotype, *C. typica*, n. sp.

Columbocystis typica, n. sp. Figs. 1, 2

Theca oval, with a conspicuous flattened protuberance at the top; height 24 mm, width 18 mm. Anterior outline distinctly gibbous along its upper third, while the posterior presents its strongest convexity at midheight. From a lateral point of view the major axis of the theca appears oblique, extending from the upper anterior toward the lower posterior thecal border, and the upper flattened face of the food-groove platform slopes in the same general direction. The platform, 8 mm in width and 6.5 mm long from front to rear, consists of five plates 2.5 to 3 mm in height extending laterally beyond the upper margins of the supporting thecal plates. These plates form an elevation about 2 mm in height and 6 mm in diameter immediately beneath the platform.

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received June 19, 1950.

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Occurrence.—Blackriveran (Benbolt formation), Rye Cove, Scott County, Va.

Cotypes.—U. S. N. M. no. 93407.

Foerstecystis, n. gen.

Like *Columbocystis* in general form but characterized by five relatively broad arms recumbent upon top of theca. Antanal side bears the strongly excentric base. Anal side very gibbous, especially toward lower end of theca, where it is angularly protuberant in a nearly horizontal direction. Plates much reduced in number and angulations connecting their centers correspondingly accentuated. Named in memory of Dr. A. F. Foerste.

Genotype, *F. obliqua*, n. sp.

Foerstecystis obliqua, n. sp. Figs. 11, 12

Theca irregularly rotund in outline; cotypes each about 10 mm high and 8 mm wide. Anterior side presenting a strongly convex vertical outline or hump, which reaches its maximum convexity about 6 mm from the anterior arm of the food-groove system. Posterior outline strongly protuberant near the midheight of the specimen, and still more so at its lower margin, where it terminates in a rounded point fully 8 mm distant from the pointed base of the specimen in a horizontal direction. Oral end of theca supports a sessile food-groove system, with five branches or arms, each 4 mm long and 2.5 mm wide spreading over an area 7 or 8 mm in diameter.

Occurrence.—Blackriveran (Benbolt formation), Knoxville, Tenn.

Cotypes.—U. S. N. M. no. 93400.

BATHEROCYSTIDAE, n. fam.

Proposed for the unusual new genus *Batherocystis*, named in memory of Dr. F. A. Bather. Family characters now necessarily those of the genus

Batherocystis, n. gen.

Theca oblong, strongly flattened, with the lateral margins of the flattened sides tapering decidedly toward the base. Anal opening relatively large, located along the upper part of one of the lateral margins.

Genotype, *B. appressa*, n. sp.

Batherocystis appressa, n. sp. Figs. 4, 5

Theca strongly compressed, presenting two flat sides connected by a narrowly rounded margin. Flat sides oblong in general outline but narrowed to a point slightly over 2 mm wide at the base. Height 25 mm, width 12 mm, thickness of theca, from one flattened surface to the other, about 1.7 mm. Anal area located on one of the narrowly rounded thecal margins, oval in outline, 2.5 mm in diameter vertically and 1.9 mm laterally, with its center 5 mm below the top of the theca.

Occurrence.—Chazyan (Lenoir limestone), Knoxville, Tenn.

Holotype.—U. S. N. M. no. 99394.

Class PARACRINOIDEA Regnéll, 1945

Family MALOCYSTITIDAE Bassler, 1943

Billingsocystis, n. gen.

Theca ovoid-oblong slightly flattened, with food-groove system imperfectly known but apparently confined to a single short, transverse, relatively deep, semilunate groove. No branches of this groove and no facets for the attachment of arms are present. Thecal plates many, all strongly ridged in a direction radiate to the angles. Columns cylindrical consisting of very thin columnals attached to the invaginated base. Named in remembrance of Elkanah Billings.

Genotype, *B. invaginata*, n. sp.

Billingsocystis invaginata, n. sp. Fig. 17

Theca oblong, moderately flattened laterally, base invaginated, with the column attached to its central part. Height 27 mm, greatest width 25 mm, least width 22 mm, depth of invagination about 2 mm. Anal area nearly 3 mm in diameter, with its center about 6 mm below the level of the top of the theca. Theca consisting of approximately 175 plates; 8 or 9 of these occur in a distance equaling the height of the theca. Ornamenting ridges radiating from raised centers of the plates toward their angles are narrowly angular, have sharp crests, and enclose intermediate flat triangular areas.

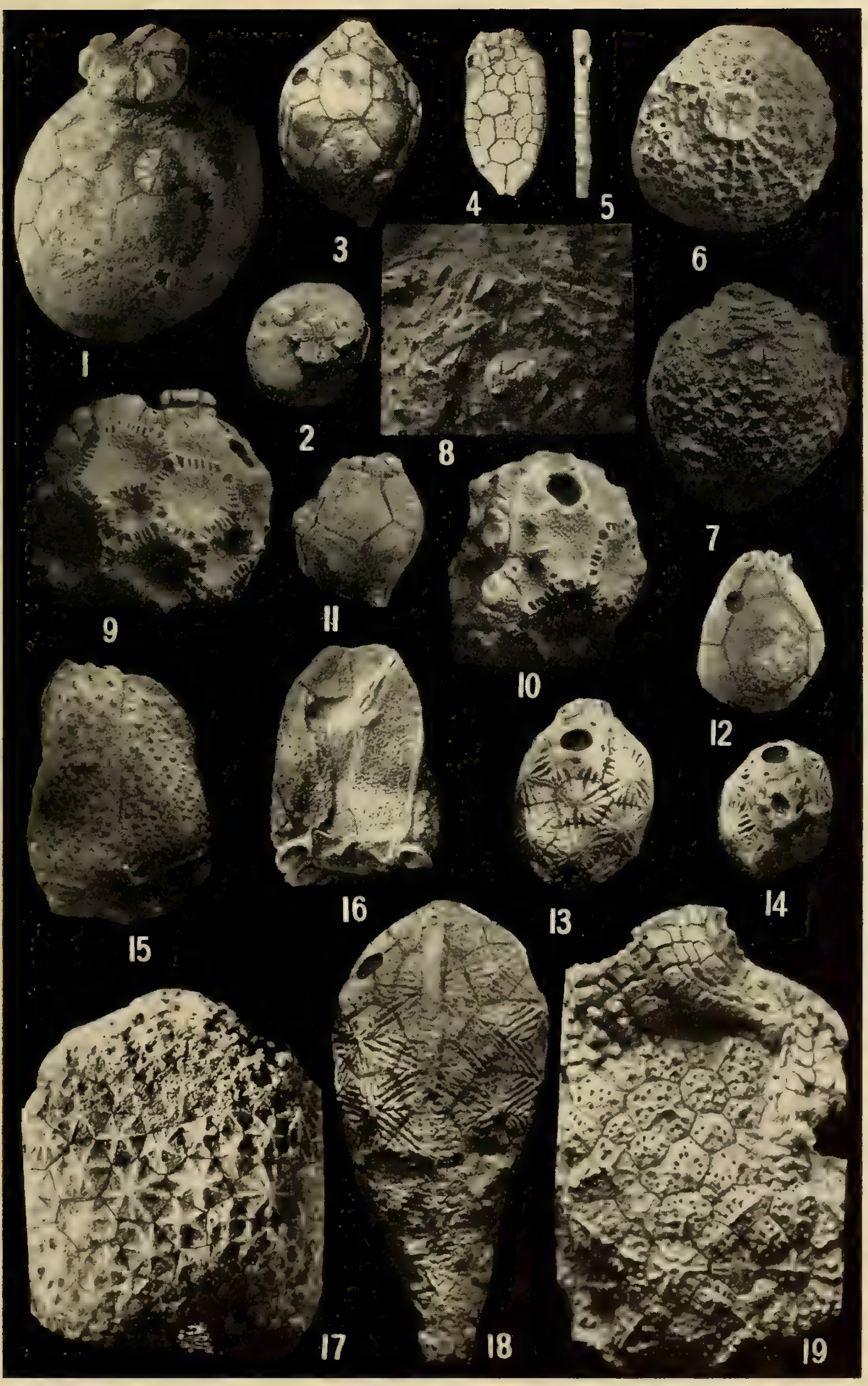
Occurrence.—Lower Trenton (probably Curdsville member), on the Versailles and Troy Pike, in Woodford County, Ky.

Cotypes.—U. S. N. M. no. 53110.

Family COMAROCYSTITIDAE Bassler, 1943

Schuchertocystis, n. gen.

Theca resembling a small *Amygdalocystites* but lacking recumbent arms. The base consists of three plates, two on the antanal and one on the anal side. Plate sutures crossed at right angles by long slits in the mesostereom that shorten at their passage through the hypostereom into ellip-



FIGS. 1–19.—1, 2, *Columbocystis typica*, n. gen. and sp., side view slightly tipped to show anal pyramid, × 2, and top view, × 1; 3, *Springerocystis longicollis*, n. gen. and sp., side view with anal opening to left, × 1; 4, 5, *Batherocystis appressa*, n. gen. and sp., side and edge views with anal opening, × 1; 6–8, *Regnellicystis typicalis*, n. gen. and sp., basal and side views, × 2, and part of latter enlarged; 9, 10, *Sinclairocystis praedicta*, n. gen. and sp., side view, × 2, with anal pore to right and top view with two arms on left, × 2; 11, 12, *Foerstecystis obliqua*, n. gen. and sp., two cotypes, × 2, one showing the anal opening and the other the opposite side; 13, 14, *Schuchertocystis radiata*, n. gen. and sp., anal and top views, × 2; 15, 16, *Kirkocystis papillata* (Bassler, 1943) (Enoploura?), convex and opposite side of two cotypes, × 4; 17, *Billingsocystis invaginata*, n. gen. and sp., side view of one of the cotypes, × 2; 18, *Ulrichocystis eximia*, n. gen. and sp., anal opening and traces of arm, × 2; 19, *Strimplecystis oklahomensis*, n. gen. and sp., the fragmentary type, × 2, showing plates with diplopores and remains of arms.

tically elongate pores. Named in remembrance of Dr. Charles Schuchert.

Genotype, *S. radiata*, n. sp.

Schuchertocystis radiata, n. sp. Figs. 13, 14

Theca 13 mm high, 7.5 to 9.5 mm wide, ovate in lateral outline, flattened in a direction oblique to the axis passing through the anal area. From the widest part, about 4 mm below the top a short distance below the anal area, the theca narrows downward to a width of 8 mm at a point 5 mm above its base, which is about 1.5 mm in width where it was probably attached to a column of still smaller dimensions. The latter is located strongly excentrically on the antanal side of the theca. The lower part of the thecal outline along its anal side is strongly protuberant, while on the antanal side it is relatively straight.

Occurrence.—Blackriveran (Benbolt formation), Washburn, Grainger County, Tenn.

Holotype.—U. S. N. M. no. 53108.

Sinclairocystis, n. gen.

Like *Comarocystites*, but instead of having four free arms it has two recumbent ones rising vertically from the theca. Named in honor of Dr. G. Winston Sinclair, who had predicted the occurrence of this type of cystoid just preceding its discovery.

Genotype, *S. praedicta*, n. sp.

Sinclairocystis praedicta, n. sp. Figs. 9, 10

Represented by four specimens, of which the holotype, 20 by 20 mm high and wide and 15 mm thick, best exhibits the characteristic *Comarocystites* plate structure and shows the two recumbent arms of stout plates extending about two-thirds of the way to the base.

Occurrence.—Blackriveran (Bromide formation, near top of green shale), 1.8 miles south of Sulphur, Okla.

Holotype.—U. S. N. M. no. 116332.

Class CYSTOIDEA Von Buch, 1846

Order Rhombifera Zittel, 1879

Ulrichocystidae, n. fam.

Characters same as in the genus.

Ulrichocystis, n. gen.

Theca fusiform, with an elliptical opening at its oral end surrounded by six thecal plates but with only a trace of a recumbent arm with facets for the support of brachioles. The genotype resembles *Palaeocystites dawsoni* in the arrangement of a large part of the thecal plates in vertical rows, but it differs in having only three plates in the basal series. Dedicated to Dr. E. O. Ulrich.

Genotype, *U. eximia*, n. sp.

Ulrichocystis eximia, n. sp. Fig.18

Theca fusiform or clavate in outline; height 34 mm, greatest width 15.5 mm, least width 13 mm in the same plane. The greatest width is located 10 mm below the top of the theca, from which point to the base the rate of tapering is very even. Diameter of base slightly over 3 mm. The elliptical opening at the oral end is 2.5 mm long and 1.4 mm wide, slightly broken along one edge where its width is 2.0 mm. The six surrounding plates rise gently at the margin, leaving it sharp-lipped. The anal area is 2.9 to 3.4 mm in diameter in different directions, with its center about 5 mm below the top of the theca, which consists of approximately 75 plates chiefly hexagonal in outline. The basal series is composed of three elongated plates, surmounted by a second series consisting of five plates, of which the one of the antanal side is conspicuously longer. Surmounting the five plates in the second series are five vertical rows, each including six plates, not counting the circumoral plates or those belonging to the second series.

Occurrence.—A single specimen from Luttrell, Tenn., in the Benbolt formation.

Holotype.—U. S. N. M. no. 93398.

Order Diploporita J. Müller, 1854

Regnellicystidae, n. fam.

Regnellicystis, n. gen.

This interesting diplopore is characterized by its broadly oval theca, 15 mm high and 14 mm wide, arising from four sharply marked basals and composed of many uncommonly small plates, all radially arranged and divided by sharp ridges into several compartments each pierced by a single large diplopore. In addition, the type specimen bears an anal pyramid about 2 mm wide located 3 to 5 mm below the thecal top. The latter bears five simple food grooves extending to the lower level of the pyramid and lined with thin flat brachioles. Named in honor of Dr. Gerhard Regnéll.

Genotype, *R. typicalis*, n. sp.

Regnellicystis typicalis, n. sp. Figs. 6–8

Description as above.

Occurrence.—Blackriveran (Benbolt formation), Rye Cove, Scott County, Va.

Holotype.—U. S. N. M. no. 113308.

Strimplecystis, n. gen.

Characters as in the specific description. Named in honor of Melba and Harrell Strimple.

Genotype, *S. oklahomensis*, n. sp.

Strimplecystis oklahomensis, n. sp. Fig. 19

Type and only specimen, a fragment of a calyx of many rather large radially arranged plates each pierced by a dozen or more diplopores much as in *Eumorphocystis* Branson and Pack, 1940, but differing in still preserving two short, unbranched food grooves out of probably five, each lined with a series of thin flat plates serving as brachioles. The rest of the specimen is such a jumble of plates that additional examples are necessary for more information. The tentative position assigned above seems the best under the circumstances.

Occurrence.—Blackriveran (Bromide formation, 140 feet below top), Oklahoma State Highway 99, Sec. 22, T. 1 N., R. 6 E., Oklahoma.

Holotype.—U. S. N. M. no. 115193.

Class CARPOIDEA Jaeckel 1900

Family Anomalocystitidae Bassler, 1943

Kirkocystis, n. gen. Figs. 15, 16

This new generic name, proposed in honor of Dr. Edwin Kirk, is based upon a carpoid related to *Enoploura* but differing in that the theca is composed of only two large elongate plates on the convex side and three equally long plates on the concave side. Typical *Enoploura* develops three plates in both the marginal and middle series of both sides: The surface ornamentation of small distinct papillae separated by very minutely reticulated spaces is another feature of *Kirkocystis*.

Genotype, *Enoploura? papillata* Bassler, 1943 (Amer. Journ. Sci. **241**: 695, pl. 1, figs. 3–5. 1943).

Occurrence.—Blackriveran (40′ below top Bromide formation), Rock Crossing, Criner Hills, Sec. 35, T. 5S., R. 1 E., Oklahoma.

Cotypes.—U. S. N. M. no. 113105.

PALEONTOLOGY.—*New stropheodontid brachiopods.*[1] Alwyn Williams, Glasgow University. (Communicated by G. A. Cooper.)

The following descriptions are part of a recently completed morphological and systematic study of stropheodontid Brachiopoda of North America and Europe. The proposed systematic revision will be used in a forthcoming publication on British Silurian brachiopods and is here given in outline because the results as a whole will not be in print for some time.

Most of the types are located at the U. S. National Museum, and I take this opportunity to express my deep appreciation to the authorities of the Smithsonian Institution for making all their collections available to me, and my grateful thanks to Dr. G. Arthur Cooper, curator of invertebrate paleontology and paleobotany, for helpful criticism and advice during my investigations.

Family Stropheodontidae Caster

Hercostrophia, n. gen. Figs. 1–6

Exterior.—Transversely semioval, gently concavo-convex to almost biplanate. Pseudodeltidium entire with a narrow median fold, chilidium vestigial. Ornamented by finely parvicostellate ribbing with accentuated primaries.

Ventral interior.—Hinge-line denticulate for about three-quarters its length. Diductor scars elongate, divergent, each contained by an outer and inner lateral, obtusely triangular ridge, the apices of which meet posterolaterally to form a narrow ring of shell deposit around each scar. Adductor scars fine, lanceolate, impressed posteriorly on either side of a low median ridge.

Dorsal interior.—Cardinal process lobes disjunct, socket plates vestigial. Adductor scars faintly impressed posteriorly to two pairs of ridges, an inner tuberculate pair, and an outer, low, somewhat indistinct pair.

Genotype.—*Hercostrophia alpenensis*, n. sp.

Range.—Middle Devonian.

Discussion.—The new genus includes an American group of shells presumably divergent from the shalerid stock. These forms differ from their shalerid contemporaries in the encirclement of the diductor muscle scars by the inward growth of the apices of the bounding ridges, the strong curvature to the outer bounding ridges, and the corresponding splayed flabellate appearance of

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[1] Received May 17, 1950.

the diductor scars, and in the discrete nature of the inner pair of ridges in the dorsal valve.

Hercostrophia alpenensis, n. sp. Figs. 2, 4

Dimensions (in centimeters).—

	Length	*Width*
Holotype: U.S.N.M. No. 116017	1.0	1.4
Paratype: U.S.N.M. No. 116018	0.9	1.2
Paratype: U.S.N.M. No. 116019a	1.1	1.7

Sample population (length, width, in centimeters).—0.6, 0.8; 0.6, 0.8; 0.9, 1.2; 0.9, 1.2; 0.9, 1.2; 1.0, 1.3; 1.0, 1.3; 1.0, 1.4; 1.0, 1.4; 1.0, 1.4; 1.1, 1.4; 1.1, 1.4; 1.1, 1.4; 1.2, 1.5; 1.1, 1.6; 1.1, 1.6; 1.2, 1.6; 1.2, 1.6; 1.2, 1.6; 1.2, 1.7; 1.3, 1.8; 1.4, 1.9.

Exterior.—Moderate size, transversely semioval, gently concavo-convex. Ventral interarea apsacline, pseudodeltidium entire, with a narrow median fold; dorsal interarea anacline, chilidium vestigial. Ornamented by a finely parvicostellate ribbing with strong primaries, and by strong concentric lines of growth

Ventral interior.—Hinge-line denticulate for about three-quarter length. Process pits excavate, ventral process strong. Adductor scars finely impressed, diductor scars elongated, divergent, outer and inner lateral ridges meeting postero-centrally to form a pair of narrow rings; outer ridges, anterior to the rings, only slightly curved.

Dorsal interior.—Cardinal process lobes disjunct, attachment faces directed posteriorly. Socket plates vestigial strengthened by transverse band of secondary shell material. Medial ridge long and low. Adductor scars posterior to two pairs of lateral ridges, inner pair high, tuberculate, outer pair rather indistinct.

Type material.—Holotype, U. S. N. M. no. 116017; figured paratypes, U. S. N. M. nos. 116018, 116019a; unfigured paratypes, U. S. N. M. no. 116019.

Horizon and locality.—Alpena limestone, 30′–40′ below top at Michigan Alkali Company Quarry, Alpena, Mich.

Hercostrophia robusta, n. sp. Figs. 1, 5

Dimensions (in centimeters).—

	Length	*Width*
Holotype: U.S.N.M. No. 116020	1.8	2.6
Paratype: U.S.N.M. No. 116021	1.5	2.4

Sample population (length, width, in centimeters).—1.2, 1.6; 1.2, 1.7; 1.3, 1.7; 1.6, 1.9; 1.5, 2.0; 1.6, 2.0; 1.6, 2.0; 1.5, 2.1; 1.5, 2.2; 1.6, 2.2; 1.6, 2.3; 1.8, 2.3; 1.8, 2.4; 1.9, 2.6.

Exterior.—Large, transversely semioval, very gently concavo-convex with a planate appearance. Ventral interarea apsacline, pseudodeltidium entire with a narrow median fold; dorsal interarea anacline, chilidium vestigial. Ornamented by a finely parvicostellate ribbing with strong primaries, and by concentric lines of growth.

Ventral interior.—Denticulate for about three-quarter length of hinge-line. Process pits excavate; ventral process strong. Adductor scars lanceolate, foliaceous. Diductor scars, divergent, splayed anteriorly, inner and outer lateral ridges to each scar strong, and forming a thin ring posterocentrally. Outer lateral ridges strongly curved anterior to the rings. Peripheral callus well developed.

Dorsal interior.—Unknown.

Type material.—Holotype, U. S. N. M. no. 116020; figured paratype, U. S. N. M. no. 116021; unfigured paratypes, U. S. N. M. no. 116022.

Horizon and locality.—3-foot shale on "Blue" bed; quarry at Silica, 2½ miles southwest of Sylvania, Ohio.

Discussion.—This species differs from *P. alpenensis* in (1) the consistently larger and stronger shells attained in maturity; (2) the almost planate disposition of the valves toward the periphery; (3) the pronounced curves to the outer lateral ridges bounding the diductor scars and the splayed nature of the scars themselves, and (4) the presence of a strong, low callus around the periphery.

Hercostrophia sp. Figs. 3, 6

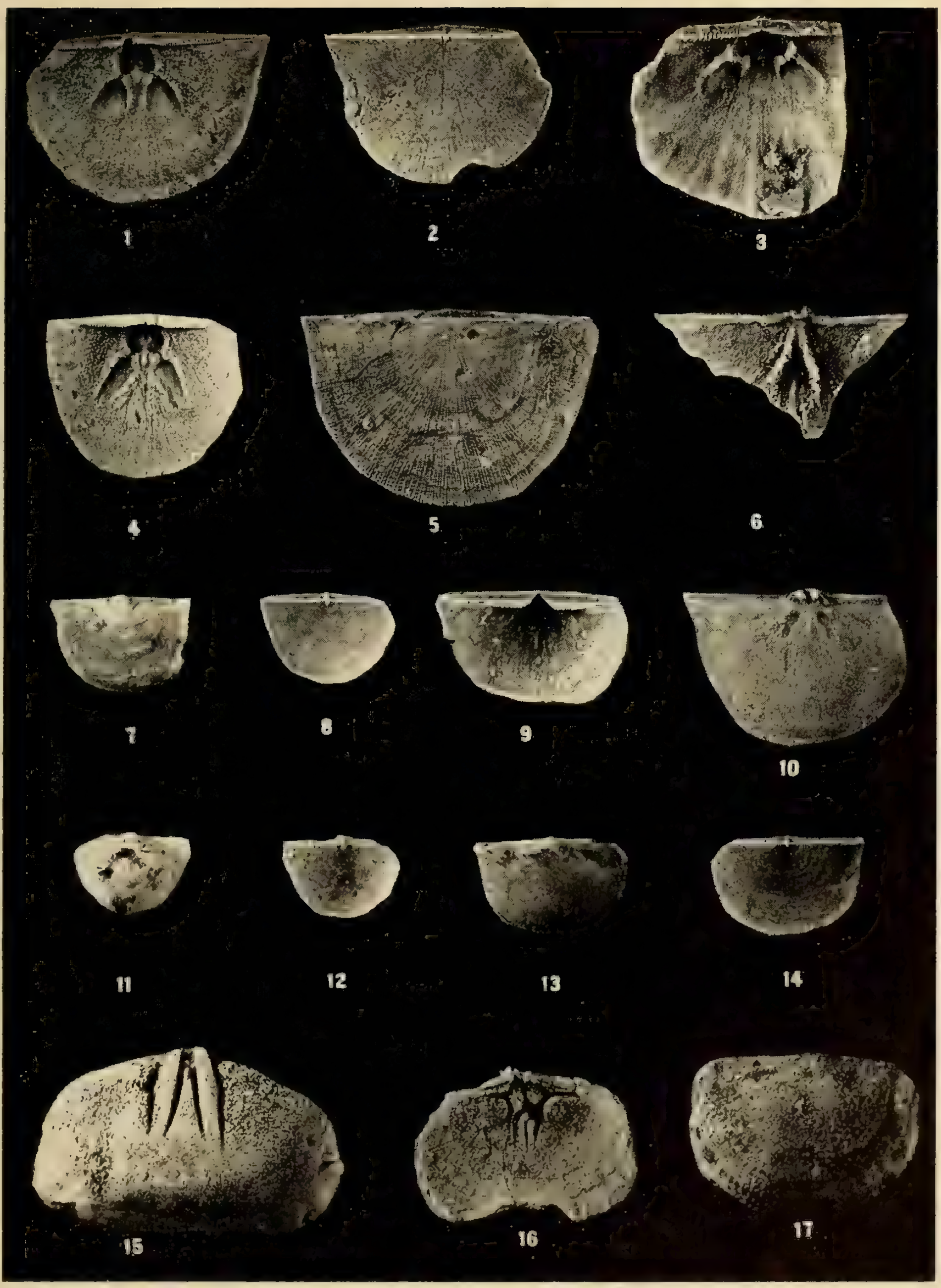
Specimens of an undescribed species often confused with *Douvillina* are figured for comparison with the Michigan and Ohio species. A fragmentary brachial valve shows details of the cardinalia.

Figured specimens.—U. S. N. M. no. 116034 a, b.

Horizon and locality.—Hamilton group, Canandaigua Lake, N. Y.

Pholidostrophia (Mesopholidostrophia), n. subg. Figs. 7–10

Silurian pholidostrophids possessing an incompletely developed pseudodeltidium, a prominent



Figs. 1, 5.—*Hercostrophia robusta*, n. sp.: 1, Ventral interior of paratype (U.S.N.M. no. 116021), × 2; 5, dorsal view of complete shell of holotype (U.S.N.M. no. 116020), × 1½.

Figs. 2, 4.—*Hercostrophia alpenensis*, n. sp.: 2, Dorsal view of almost complete shell of paratype (U.S.N.M. no. 116018), × 2; 4, ventral interior of holotype (U.S.N.M. no. 116017), × 2.

Figs. 3, 6.—*Hercostrophia* sp.: 3, Ventral interior of U.S.N.M. no. 116034a, × 2; 6, dorsal interior of U.S.N.M. no. 116034b, × 2.

Figs. 7–10.—*Pholidostrophia* (*Mesopholidostrophia*) *nitens*, n. subg. and sp.: 7, Ventral exterior of holotype (U.S.N.M. no. 116023), × 2; 8, dorsal view of entire specimen, a paratype (U.S.N.M. no. 116024a), × 2; 9, ventral interior of paratype (U.S.N.M. no. 116024b), × 3; 10, dorsal interior of paratype (U.S.N.M. no. 116024c), × 3.

Figs. 11, 12.—*Lissotrophia* (*Mesolissostrophia*) *minuta*, n. subg. and sp.: Ventral and dorsal views of an entire shell, holotype (U.S.N.M. no. 116028), × 2.

Figs. 13, 14.—*Lissostrophia* (*Mesolissostrophia*) *pellicida*, n. subg. and sp.: Ventral and dorsal views of an entire shell, holotype (U.S.N.M. no. 116026), × 2.

Figs. 15–17.—*Shaleria* (*Telaeoshaleria*) *sulcata*, n. subg. and sp.: 15, Mold of ventral interior of paratype (U.S.N.M. no. 116031), × 2; 16, mold of dorsal interior of paratype (U.S.N.M. no. 116023), × 1½; 17, ventral interior of holotype (U.S.N.M. no. 116030), × 2.

to vestigial chilidium, a conjunct to incipiently disjunct cardinal process, and progressively degenerate socket plates. Muscle scars pholidostrophid but not impressed.

Genotype.—*Pholidostrophia* (*Mesopholidostrophia*) *nitens*, n. sp.

Discussion.—Differs from *Pholidostrophia* (*Pholidostrophia*) Hall and Clarke (1892, p. 287), which is here emended to include only forms with a smooth pseudodeltidium, no chilidium, a disjunct cardinal process, no socket plates, and strongly impressed muscle scars.

Pholidostrophia (Mesopholidostrophia) nitens, n. sp. Figs. 7–10

Dimensions (in centimeters).—

		Length	*Width*
Holotype:	U.S.N.M. No. 116023	0.65	0.96
Paratypes:	U.S.N.M. No. 116024a	0.6	0.9
	U.S.N.M. No. 116024b	0.7	1.2
	U.S.N.M. No. 116024c	0.65	1.0

Exterior.—Outline transversely semioval, mucronate, concavo-convex with a slight to moderate, even curvature to the valves. Ventral interarea apsacline, pseudodeltidium very small, dorsal interarea anacline, chilidium massive. Surface pseudonacreous, lamellose, free of radial ornamentation except for traces of fine primary costellae buried under the lamellose layer. Lamellose material heavily deposited toward the periphery to break the contour of the shells with concentric overlapping edges.

Ventral interior.—Hinge-line denticulate for less than half the length. Process pits very lightly impressed. Ventral process faintly developed. Adductor scar lanceolate impressed posteriorly and divided medianly by a very fine septum, diductor scars subcircular feebly impressed.

Dorsal interior.—Cardinal process lobes slender, socket plates small. Notothyrial platform virtually absent, adductor scars lightly impressed subquadrate contained posterolaterally by bounding ridges and divided by a feeble median ridge.

Type material.—Holotype, U. S. N. M. no. 116023; figured paratypes, U. S. N. M. nos. 116024a–c; unfigured paratypes, U. S. N. M. no. 116025.

Horizon and locality.—"Gotlandian," brickyard near Klintehamn, Gotland.

Discussion.—The large amount of excellent material available at the U. S. National Museum indicates that this stock is fairly common in the Middle Silurian "shales" of Gotland, but so far as I am aware it has not been described. For purposes of close comparison between this species and any other undescribed material that exists, the following measurements of a U. S. N. M. sample are given (length of the shell followed by width of the shell at the hinge-line, in centimeters): 0.79, 1.25; 0.69, 1.00; 0.60, 0.94; 0.69, 1.00; 0.45, 0.69; 0.63, 0.97; 0.47, 0.63; 0.75, 1.10; 0.79, 1.10; 0.46, 0.79; 0.63, 0.94; 0.59, 0.72; 0.60, 0.87; 0.46, 0.69; 0.63, 1.00; 0.50, 0.90; 0.45, 0.79; 0.58, 0.91; 0.60, 0.91; 0.49, 0.85; 0.79, 1.06; 0.60, 1.10; 0.60, 1.00; 0.25, 0.35; 0.17, 0.25.

Lissostrophia (Mesolissostrophia), n. subg. Figs. 11–14

Erected to include Lower Silurian lissostrophids with an incompletely developed pseudodeltidium, a strong to vestigial chilidium, conjunct to incipiently disjunct cardinal process, abbreviated to obsolescent socket plates, and faintly impressed lissostrophid muscle scars.

Genotype.—*Lissostrophia* (*Mesolissostrophia*) *pellucida*, n. sp.

Discussion.—Differs from *Lissostrophia* (*Lissostrophia*) Amsden, 1949 (p. 202), which is here emended, in that the latter subgenus embraces forms with a smooth pseudodeltidium, no chilidium, a disjunct cardinal process, no socket plates, and strongly impressed muscle scars.

Lissostrophia (Mesolissostrophia) pellucida, n. sp. Figs. 13, 14

Dimensions (in centimeters).—

		Length	*Width*
Holotype:	U.S.N.M. No. 116026	0.7	1.1
Paratypes:	U.S.N.M. No. 116027a	0.7	1.1
	U.S.N.M. No. 116027b	0.64	0.94

Exterior.—Rather small, transversely oval in outline, mucronate, concavo-convex with a low curvature to the valves. Ventral interarea apsacline, pseudodeltidium incipient, dorsal interarea anacline, chilidium large. Shell smooth, pellucid, ornamented only by fine concentric lines of growth.

Ventral interior.—Denticulate for a short distance on each side of the delthyrium. Process pits faintly excavate, ventral process incipiently developed, muscle scar obscure.

Dorsal interior.—Cardinal process lobes elongated conjunct, socket plates abbreviated, adductor scars obscure, median ridge low.

Type material.—Holotype, U. S. N. M. no. 116026; paratypes, U. S. N. M. nos. 116027a, b.

Horizon and locality.—"Gotlandian," brickyard near Klintehamn, Gotland.

Lissostrophia (Mesolissostrophia) minuta, n. sp. Figs. 11, 12

Dimensions (in centimeters).—

	Length	*Width*
Holotype: U.S.N.M. No. 116028	0.4	0.6
Paratypes: U.S.N.M. No. 35649a	0.42	0.52
U.S.N.M. No. 116029a	0.38	0.4

Exterior.—Very small, elongately oval in outline, mucronate, concavo-convex with a high degree of curvature. Shell smooth, pellucid, ornamented by a few concentric growth lines. Ventral interarea apsacline, pseudodeltidium incipient, dorsal interarea anacline, chilidium large, convex.

Interiors unknown.

Type material.—Holotype, U. S. N. M. no. 116028; paratypes, U.S.N.M. nos. 35649, 116029a.

Horizon and locality.—Waldron shale, Newsom, Tenn.

Shaleria (Telaeoshaleria), n. subg. Figs. 15–17

Devonian shalerids with an entire pseudodeltidium folded medianly, vestigial chilidium, divergent ventral muscle scars with the median septum bifurcated posteriorly dorsal muscle scar platform elevated with the anterior parts of the outer ridges indistinct and the inner plates fused posteriorly.

Genotype.—*Shaleria* (*Telaeoshaleria*) *sulcata*, n. sp.

Discussion.—The Silurian and early Devonian shalerids included in *Shaleria* (*Shaleria*) Caster, 1939 (p. 33), emended differ from these end stock members in having an incompletely developed pseudodeltidium, a strong to weak chilidium, ventral muscle scars lying parallel to each other with the median septum bifurcated posteriorly, and a weakly developed dorsal muscle scar platform with the four anterior ridges strong and discrete.

Shaleria (Telaeoshaleria) sulcata, n. sp. Figs. 15–17

Dimensions (in centimeters).—

	Length	*Width*
Holotype: U.S.N.M. No. 116030	1.1	1.6 (est.)
Paratypes: U.S.N.M. No. 116033a	1.3	2.0
U.S.N.M. No. 116032	1.2	1.8

Exterior.—Moderate size, subquadrate, moderately concavo-convex, slightly geniculate, dorsal and ventral valves with a complementary fold and sulcus anteromedianly. Ventral interarea apsacline, pseudodeltidium entire but with narrow fold; dorsal interarea anacline, chilidium obsolete. Ribbing finely parvicostellate with strong rather widely spaced primaries.

Ventral interior.—Hinge-line denticulate for the entire length of the body chamber. Diductor scars narrow, long, divergent, bounded laterally by high septa the inner pair of which resulted from the posterior bifurcation of the median septum. Adductor scars narrow, small, impressed posteriorly on either side of the median septum.

Dorsal interior.—Cardinal process lobes disjunct socket plates vestigial. Adductor scars subcircular deeply impressed and contained by coalescence of four ridges, the inner pair of which extend anteriorly beyond the platform, parallel to each other and separated by a small thin median ridge.

Type material.—Holotype, U. S. N. M. no. 116030; figured paratypes, U.S.N.M. nos. 116031, 116032; unfigured paratypes, U. S. N. M. nos. 116033.

Range.—Middle Devonian (Calceola beds).

Type locality.—Lissingen, Eifel, Germany.

Douvillina (Mesodouvillina), n. subg.

Erected to include Silurian douvillinids with an incompletely developed pseudodeltidium, prominent to vestigial chilidium, conjunct to incipiently disjunct cardinal process, short socket plates, no anterior bounding ridges to the ventral muscle scar, and poorly defined braceplates occurring as a pair of low ridges anterior to the dorsal muscle scar.

Genotype.—*Brachprion subinterstrialis serentensis* Kozlowski (1929, pp. 96–99, figs. 28–29; pl. 4, figs. 1–7).

Discussion.—*Douvillina* (*Douvillina*) Oehlert, 1887 (p. 1282), is here restricted to those Devonian forms in which the pseudodeltidium is entire but folded medianly, the chilidium and socket plates obsolete, the cardinal process disjunct, the ventral muscle scars progressively contained by strong lateral and anterior bounding ridges, and well developed braceplates. These are the essential differences between the two subgenera.

Strophonella (Eostrophonella), n. subg.

Erected to include lower Silurian strophonellids with dental plates supporting the denticulate zone of the hinge-line, an incipiently developed pseudodeltidium, platelike cardinal process lobes, long divergent socket plates, and a subcircular ventral muscle scar.

Genotype.—Strophonella davidsoni Holtedahl, 1916 (pp. 64–65, pl. 7, figs. 6, 7).

Discussion.—Strophonella (*Strophonella*) Hall, 1879 (p. 152), is here restricted to include forms characterized by having no dental plates, a progressively developed pseudodeltidium stout cardinal process lobes, short to obsolescent socket plates and a petaloid ventral muscle scar. These are the essential differences between the two subgenera.

Glossostrophia, n. gen.

Exterior.—Transversely semioval; geniculately resupinate but with a narrow median zone of the geniculate portion projecting dorsally like a tongue. Pseudodeltidium entire with a narrow median fold, chilidium vestigial. Ornamented by fine parvicostellae with strong primaries.

Ventral interior.—Hinge-line denticulate for about three-quarters its length. Muscle scar subtriangular in outline, lateral bounding ridges strongly developed posterolaterally.

Dorsal interior.—Cardinal process lobes disjunct, socket plates robust, lying adjacent to the cardinal process lobes. Adductor scars suboval, contained laterally by a pair of high short ridges and anteriorly by a pair of low subcircular, elevated areas.

Genotype.—Leptaena caudata Schnur (1854, p. 224, pl. 42, fig. 4a–c).

Range.—Middle Devonian.

Discussion.—This genus is erected for a group of resupinate forms, closely related to the leptostrophid-nervostrophid stock unique among all stropheodontids in possessing the dorsally projecting tonguelike process. One other resupinate group of this stock is known, namely, *Gamphalosia* Stainbrook (1945, p. 33). In addition to the difference cited above, *Gamphalosia* is ornamented in a nervate fashion as opposed to the parvicostellate type of *Glossostrophia*. No internal comparisons are possible because the interiors of *Gamphalosia* are unknown.

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BOTANY.—*Three new Carices from Mexico and Guatemala.* Frederick J. Hermann.[1] U. S. Department of Agriculture.

Among an extensive collection of sedges made by Dr. A. J. Sharp in Mexico and Guatemala and an earlier collection made by Dr. C. H. Muller in Chihuahua the following undescribed species were found:

Carex percostata, sp. nov. (Multiflorae). Rhizomata crassa, lignea, memnonia, fibrillosa; culmi 3–6 dm alti, obtuse triangulares, infra capitulum scaberuli alibi laeves, foliis multo longiores; folia 3–6, ad basim culmi aggregata, vaginis ventraliter paulum ore productis, ligula brevi, laminis planis, rigidis, 1–3 dm longis, 3–4 mm latis, marginibus ad apicem attenuatum scabriusculis; capitulum late oblongum vel ovoideo-oblongum, 2–2.5 cm longum, 1–1.5 cm latum; spicae 7–12 androgynae, aggregatae vel infimae plus minusve disjunctae, ovoideae, perigyniis 5–8 adscendentibus patentibusve parte mascula conspicua; bracteae squamiformes vel infima setaceo-producta; squamae ovatae, acutae vel brevicuspidatae, perigyniis breviores; perigynia inaequaliter biconvexa, oblongo-ovoidea, 4–5 mm longa, 2.25–2.5 mm lata, fulvo-straminea apice brunnea,

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[1] Received June 9, 1950.

coriacea, nitentia, utrinque 10–15-costata sulcataque marginibus paulum acutis in rostrum breve serrulatum abrupte attenuatum, ad basim stipitatam valde spongiosam contracta; achaenia lenticularia obovata, olivacea, 2.5 mm longa, 2.2 mm lata.

Rootstocks stout, woody, short-creeping, blackish, fibrillose; culms 3–6 dm high, erect, about twice the length of the leaves, bluntly triangular and coarsely ribbed, smooth except below the head where scaberulous, phyllopodic; leaves 3–6 to a fertile culm, clustered near the base, the sheaths hyaline ventrally, scarcely prolonged at the mouth, the ligule short, usually broader than long, the blades flat, stiff, dull green, 1–3 dm long, 3–4 mm wide, the margins roughened toward the long-attenuate apex; head broadly oblong to ovoid-oblong, 2–2.5 cm long, 1–1.5 cm wide, the spikes 7–12, androgynous, aggregated or the lower more or less separate, ovoid, with 5–8 ascending or at length spreading perigynia, the staminate portion prominent; bracts squamiform, the lower one or two generally abruptly setaceous-prolonged; scales ovate, acute or short-cuspidate, narrower than and about the length of the bodies of the perignyia, dirty brown with very narrow hyaline margins and stramineous 1–3-nerved center; perigynia unequally biconvex, oblong-ovoid, 4–5 mm long, 2.25–2.5 mm wide, lustrous, tawny-stramineous the upper half becoming brown, coriaceous, heavily 10–15-ribbed and furrowed on both faces, scarcely sharp-edged, serrulate on the upper third, abruptly tapering into a serrulate, bidentulate, dorsally cleft beak one-fourth the length of the body; the base very spongy and rounded or abruptly tapering to a short stipe; achenes lenticular, obovate, olive-brown, 2.5 mm long, 2.2 mm wide, apiculate; style slender, straight; stigmas 2, slender, straight.

Mexico: Scattered on wet meadows in open pine forest, 20 miles north of Madera, Municipio de Madera, Chihuahua, September 27, 1939, *C. H. Muller 3520* (type, U. S. National Arboretum Herbarium); dried pool in bottom of sink west of Chilpancingo, alt. 6,000 feet, Guerrero, October 20, 1944, *A. J. Sharp 441375* (U. S. National Arboretum Herbarium; University of Tennessee Herbarium).

Nearest allied to *Carex marienensis* Stacey (*C. autumnalis* Mack., not Ohwi), a montane species known from the states of México, Oaxaca, Hidalgo, and Chihuahua, and like it maturing unusually late in the season. From this it differs strikingly in its perigynia which are unequally biconvex rather than planoconvex, larger (4–5 by 2.25–2.5 mm, rather than 3.5–4 by 1.5–2 mm), more abruptly and shorter-beaked (the beak one-fourth rather than one-half the length of the body), scarcely sharp-margined, lustrous and heavily ribbed and sulcate on both faces. The achenes, too, are larger (2.5 by 2.2 mm instead of 2 by 1.5 mm) and darker, the spikes fewer-flowered and with a much more conspicuous staminate portion, the heads shorter and broader and the sheaths not obviously prolonged at the mouth.

Carex atractodes, sp. nov. (Granulares). Caespitosa e rhizomatibus modice validis; culmi 1.5–4 dm alti, obtuse triangulares, folia paulum superantes; folia 2–4, laminis 5–25 cm longis, 2–6 mm latis, planis, ad apicem minute scabriusculis; spica terminalis mascula, 6–12 mm longa, 1.2–2 mm lata, brevipedunculata vel subsessilis, squamis oblongis, plus minusve carinatis; spicae femineae 3 vel 4, erectae, lineari-oblongae, 5–14 mm longae, 3–5 mm latae, compacte 10–25-florae, infima pedunculo capillari, bracteis frondosis inflorescentiam superantibus, lamina infima 4–12 cm longa, vaginis longis (usque ad 24 mm); squamis elliptico-lanceolatis, 2 mm longis, hyalinis costa viridi-carinata, perigyniis dimidio brevioribus; perigynia fusiformia, 3–3.3 mm longa, 1.5 mm lata, conspicue multinervia, coriacea, atroviridia, in rostrum breve integrum contracta; achaenia triangularia, obovoidea, 1.8 mm longa, 1.1 mm lata, stipitata, stylo recto.

More or less cespitose from moderately stout, dark brown, creeping rootstocks; culms 1.5–4 dm high, phyllopodic, slender, flexuous, little exceeding the leaves, bluntly triangular, smooth or minutely scabridulous between the veins; leaves 2–4 to a fertile culm, mostly on the lower third of the culm, the blades flat, erect, 5–25 cm long, 2–6 mm wide, linear, scaberulous toward the apex, the sheaths loose, hyaline and early ruptured ventrally, the ligule prolonged, acuminate, many times longer than wide; staminate spike linear, erect, subsessile and often concealed between the two uppermost pistillate spikes or short-peduncled (peduncle up to 3 mm long), 6–12 mm long, 1.2–2 mm wide, the scales oblong, bluntly acute to minutely cuspidate, 3.5 mm long, appressed-ascending, pale reddish brown with a broad light green, more or less carinate midrib, usually scabridulous toward the apex; pistillate spikes 3 or 4, erect, the lowermost widely separate on a long-exserted, capillary peduncle, the upper short-peduncled or sessile, linear-oblong, 5–14 mm long, 3–5 mm wide, closely 10–25-flowered, the perigynia ascending; bracts large and leaflike, generally exceeding the inflorescence, the blade of the lowermost 4–12 cm long, the sheaths long (to 24 mm) somewhat prolonged at the mouth and the ligule conspicuous; scales elliptic-lanceolate, acuminate, 2 mm long and about half the length of the perigynia, thin, hyaline and tinged with reddish brown except for the stout, green, carinate midrib; perigynia fusiform, 3–3.3 mm long, 1.5 mm wide, sessile, prominently many-nerved, coriaceous, closely investing the achene, dark green, shading to chestnut-brown at the base, resinous-puncticulate, tapering into a short, straight, entire beak; achenes trigonous, broadly obovoid, 1.8 mm long, 1.1 mm wide, brown, granular, tapering to the short-stipitate base, abruptly rounded at the apex, conspicuously straight-apiculate, jointed with the short, slender style; stigmas 3, slender, reddish brown.

MEXICO: Edge of ditch near Lake Jusnajav, alt. 5,500 feet, about 16 km northwest of Comitan, Chiapas, April 29, 1945, *A. J. Sharp 45450* (type, U. S. National Arboretum Herbarium, duplicate in University of Tennessee Herbarium).

No representatives of the section Granulares have heretofore been reported south of the United States, although *Carex microdonta* Torr. & Hook. is of frequent occurrence in eastern Texas and occasional in the Trans-Pecos area, and *C. rectior* Mack. is known from Alabama and Louisiana. The present species is most closely related to *C. haleana* Olney, which ranges from Quebec and Maine to Saskatchewan, southward to Virginia, Indiana, and Kansas. It is set off from *C. healeana* by its fusiform perigynia (hence the specific epithet), which are longer (3–3.3 mm rather than 2–2.5 mm), notably dark-green, tapering into a more prominent beak and never rounded at the base; by its relatively long pistillate scales (one-half rather than one-fourth the length of the perigynia); and by its stout, creeping rootstocks.

Carex quichensis, sp. nov. (Granulares). Dense caespitosa e rhizomatibus tenuibus; culmi 1.8–4 dm alti, laeves, obtuse triangulares, foliis breviores; folia 3–5, laminis 9–20 cm longis, 3.5–6 mm latis, planis, marginibus ad apicem scabriusculis; spica terminalis mascula, 14–25 mm longa, 1.5–2 mm lata, pedunculo 3–5 mm longo, squamis elliptico-oblongis, mucronatis, costa laevi; spicae laterales femineae vel saepe androgynae 3 vel 4, erectae, lineares 20–30 mm longae, 3.5–5 mm latae, 15–30-florae, infima pedunculo capillari, bracteis frondosis inflorescentiam superantibus, lamina infima 15–20 cm longa, vaginis perlongis (usque ad 45 mm); squamis late elliptico-lanceolatis, 3 mm longis, hyalinis costa viridi saepe plus minusve carinata frequenter mucronatis perigynia subaequantibus; perigynia late ellipsoidea vel anguste obovoidea, 3.2 mm longa, 1.3–1.5 mm lata, conspicue multinervia, subcoriacea, olivacea, basi cuneata, in rostrum breve (0.35 mm) rectum subintegrum ore incrassato abrupte contracta; achaenia triangularia, anguste obovoidea, 2 mm longa, 1 mm lata, stipitata, stylo adunco.

Densely cespitose from slender, pale brown rootstocks; culms 1.8–4 dm high, erect, overtopped by the leaves, smooth, bluntly triangular; sterile shoots conspicuously developed; leaves 3–5 to a fertile culm, the blades flat, linear, erect, 9–20 cm long, 3.5–6 mm wide, scaberulous on the margins toward the apex, the lower sheaths loose, hyaline and soon breaking ventrally, the ligule not conspicuously prolonged, blunt, as long or twice as long as wide, 14–25 mm long, 1.5–2 mm wide, terminal spike staminate, linear, erect, 14–25 mm long, 1.5–2 mm wide, borne on a peduncle 3–5 mm long, the scales elliptic oblong, 4 mm long, appressed, hyaline, tinged with reddish brown, the broad dark green, often somewhat carinate, midrib smooth and extended as a mucro; lateral spikes 3 or 4, erect, pistillate or often androgynous, the lowermost widely separate on a capillary peduncle, the upper short-peduncled, linear, 20–30 mm long, 3.5–5 mm wide at maturity, 15–30-flowered, the perigynia appressed-ascending; bracts leaf-like overtopping the inflorescence, the blade of the lowermost 15–20 cm long, the sheaths, except the uppermost, very long (to 45 mm), prolonged at the mouth and with a prominent ligule; scales broadly elliptic-lanceolate, acuminate, 3 mm long, nearly equaling the perigynia, thin and hyaline, the margins streaked with dark red, the midrib stout, green, generally more or less carinate, extending to or prolonged slightly beyond the tip; perigynia broadly ellipsoid to narrowly obovoid, 3.2 mm long, 1.3–1.5 mm wide, sessile, conspicuously many-nerved, subcoriaceous, little inflated, olive-green, tapering at the base, abruptly contracted above into a short (0.35 mm), stout, straight, subentire beak conspicuously thickened at the mouth; achenes trigonous, narrowly obovoid, 2 mm long, 1 mm wide, stramineous, granular, tapering to the stipitate base, rounded at the apex, bent-apiculate and jointed with the slender style; stigmas 3, short, dark red.

GUATEMALA: Edge of brook above Nebaj; El Quiché, alt. 7,000 feet, February 7, 1945, *A. J. Sharp 45144* (type, U. S. National Arboretum Herbarium, duplicate in University of Tennessee Herbarium).

In its long, slender pistillate spikes *Carex quichensis* resembles species of the Mexican and southern Californian section Longicaules rather than those of the more northeastern section Granulares, but its apparently erect spikes and its subentire perigynium-beak, which is prominently thickened at the mouth, exclude it from the former group. In section Granulares it falls nearest to the only other known Middle American representative of the section, *Carex atractodes*, described above. From this it is readily separated by its densely cespitose habit, slender rootstocks, and short ligule; by its long terminal (14–25 mm rather than 6–12 mm long) and lateral (20–30 mm rather than 5–14 mm long) spikes, the latter often staminate at the apex, and its long pistillate scales, which nearly equal the perigynia; by its abruptly beaked perigynia; and by its sharply bent style-base.

ENTOMOLOGY.—*Two new genera and three new species of Microlepidoptera from Argentina (Gelechiidae).*[1] J. F. GATES CLARKE, Bureau of Entomology and Plant Quarantine.

The microlepidopterous fauna of Argentina is little known, though several enthusiastic workers, Fernando Bourquin and A. Pastrana of Buenos Aires and Kenneth J. Hayward and associates of Tucumán, are engaged in acquiring useful knowledge of the habits and life histories of these insects. This paper is designed to make known three more species and to provide names so that the biologies of these moths can be published.

Euchionodes, n. gen.

Figs. 1–1*e*; 5–5*b*

Typus generis.—*Euchionodes traditionis*, n. sp.

Head with spreading, appressed scales. Antenna simple, without pecten from scape. Labial palpus long, recurved, third segment as long as second; brush of second segment with furrow; third segment compressed, roughened posteriorly with a tuft of elongated scales. Tongue well developed.

Forewing elongate, ovate, 12 veins; 1 b furcate; 1 c absent, 2 distant from 3, 3–5 nearly equidistant; 7 and 8 stalked, both to costa; 11 from middle.

Hind wing slightly broader than forewing, 8 veins; 2 distant from 3, 3 from before angle; 6 and 7 divergent, approximate at base; discocellulars outwardly oblique between 2 and 6; crossvein present between cell and 8.

Hind tibia roughened with long hairlike scales.

Male genitalia.—Uncus and gnathos present, the latter a well developed hook.

Female genitalia.—Signum present.

This genus is closely related to *Chionodes* Hübner but differs from it by the scale tuft from the third segment of the palpus, vein 2 of forewing is distant from 3, and 3 of hind wing is well separated from 4. The male and female genitalia of both genera are similar and show definite relationship.

Euchionodes traditionis, n. sp.

Alar expanse, 13–16 mm.

Labial palpus ochraceous-tawny; second segment with a small fuscous spot outwardly at base and a large, subterminal, triangular fuscous spot outwardly; third segment almost wholly overlaid with fuscous. Antenna fuscous with some ochraceous-tawny scaling basally. Ground color of head, thorax, and forewing buckthorn brown, except face, which is ochraceous-tawny; head and thorax with a more or less well defined median fuscous line; forewing more or less longitudinally streaked with purplish fuscous, but in some specimens the streaking is obsolete; apex and cilia purplish fuscous. Hind wing grayish fuscous; cilia fuscous. Legs ochraceous-tawny strongly overlaid with purplish fuscous. Abdomen fuscous except the median-ventral whitish ocherous area.

Male genitalia.—As figured. Note the greatly reduced harpe.

Female genitalia.—As figured. Signum a four lobed plate with two high transverse keels.

Type.—U.S.N.M. no. 59422.

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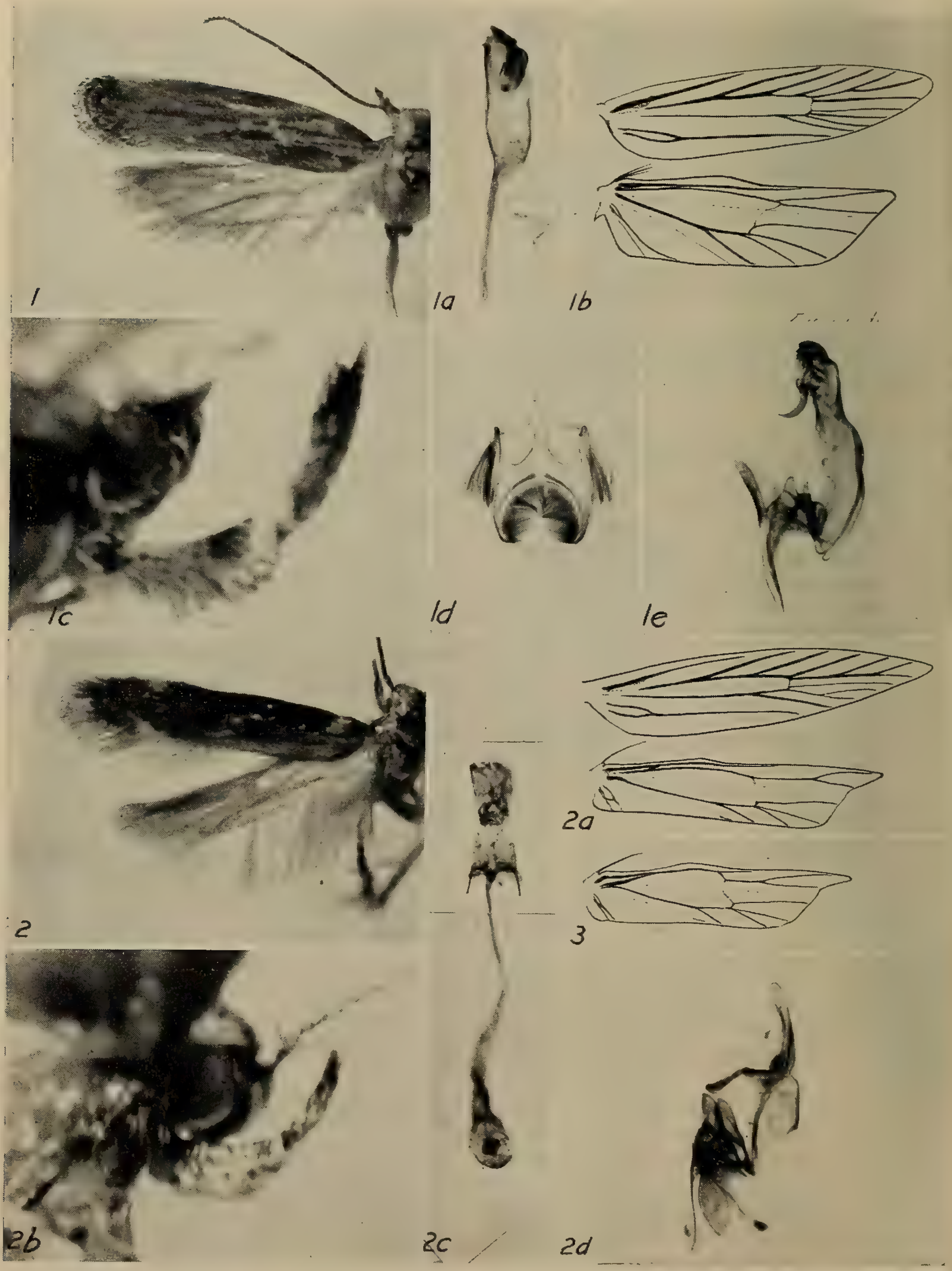
[1] Received May 8, 1950.



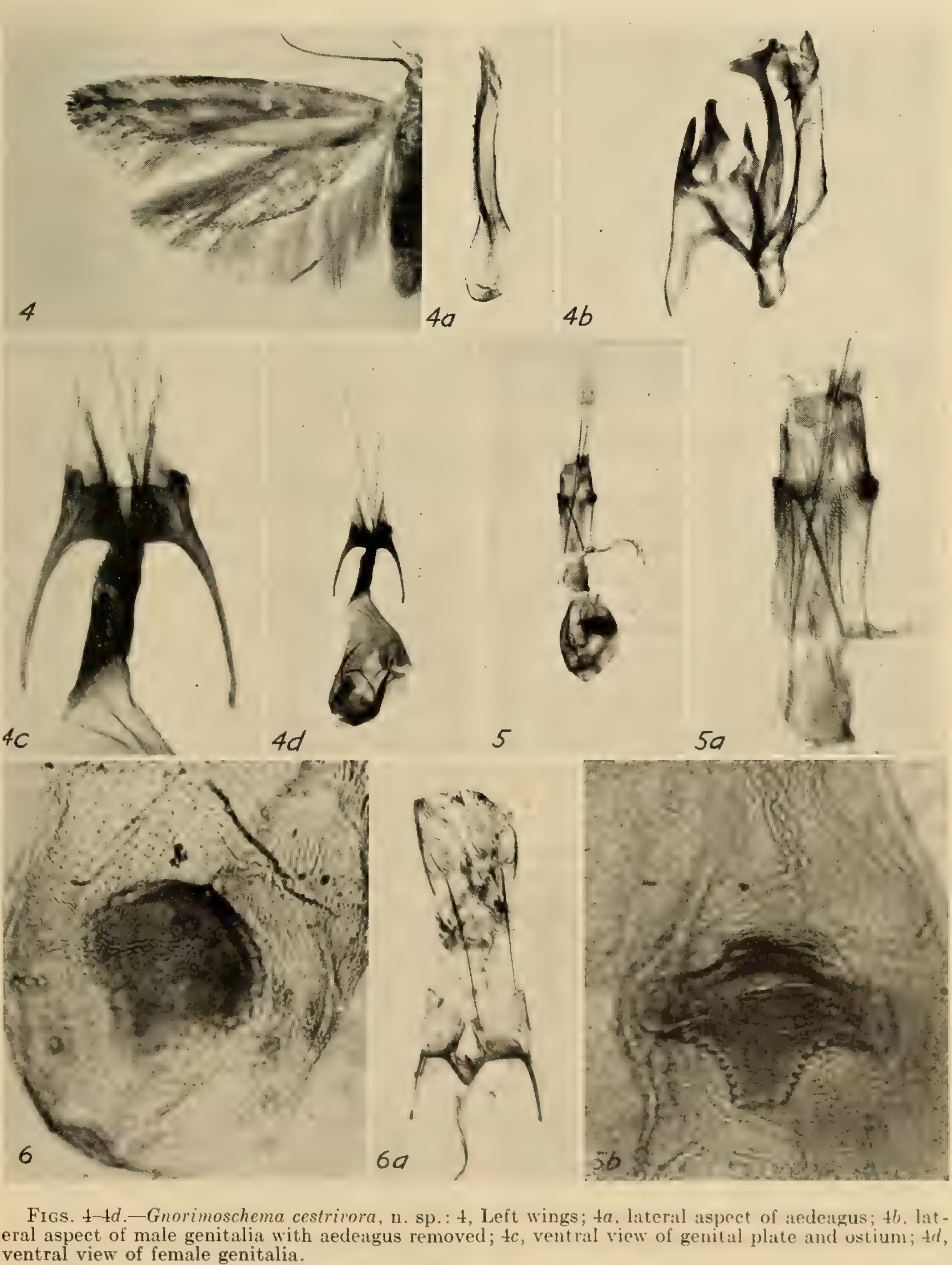
FIGS. 1–1e.—*Euchionodes traditionis*. n. sp.: 1, Left wings; 1*a*, lateral aspect of aedeagus; 1*b*, venation of right wings; 1*c*, lateral aspect of head to show palpus; 1*d*, eighth tergite and sternite; 1*e*, lateral aspect of male genitalia with aedeagus removed.

FIGS. 2–2*d*.—*Darlia praetexta*, n. sp.: 2, Left wings; 2*a*, venation of right wings; 2*b*, lateral aspect of head to show palpus; 2*c*, ventral view of female genitalia; 2*d*, lateral aspect of male genitalia with aedeagus in situ.

FIG. 3.—*Trypanisma prudens* Clemens: Venation of right hind wing.

Type locality.—Tigre, Argentina.

Remarks.—Described from the type ♂, 1 ♂, and 2 ♀ paratypes, all from the same locality and reared by Fernando Bourquin. Dates are as follows: Type, "V.41," ♂ paratype, "V.39"; 2 ♀ paratypes, "VII.39." Paratypes in U. S. National Museum and Mr. Bourquin's collection, Buenos Aires. Bourquin will publish the life history.



FIGS. 4–4*d*.—*Gnorimoschema cestrivora*, n. sp.: 4, Left wings; 4*a*, lateral aspect of aedeagus; 4*b*, lateral aspect of male genitalia with aedeagus removed; 4*c*, ventral view of genital plate and ostium; 4*d*, ventral view of female genitalia.

FIGS. 5–5*b*.—*Euchionodes traditionis*, n. sp.: 2, Ventral view of female genitalia; 2*a*, enlarged view of genital plate and ostium; 2*b*, signum.

FIGS. 6–6*a*.—*Darlia praetexta*, n.sp.: 3, Signum; 3*a*, enlarged view of genital plate and ostium.

Darlia, n. gen.

Figs. 2–2*d*; 6–6*a*

Typus generis.—*Darlia praetexta*, n. sp.

Head with appressed scales. Antenna simple, without pecten from scape. Labial palpus moderate, recurved, third segment as long as second; second segment roughened in front but without well defined brush or furrow. Tongue well developed.

Forewing narrow elongate, 12 veins; 1 b furcate, 1 c absent, 2 distant from 3, 3 and 4 long stalked; 5 approximate to stalk of 3 and 4; 6 and 7 long stalked, 7 to costa; 8 out of the stalk of 6 and 7; 9 approximate to stalk of 6 and 7; 11 from middle.

Hind wing slightly narrower than forewing, 8 veins; 2 distant from 3, 3 and 4 connate or short stalked; 6 and 7 stalked; 8 free.

Hind tibia moderately roughened with long hairlike scales.

Male genitalia.—Uncus and gnathos strongly developed.

Female genitalia.—Signum present.

This genus is closely related to *Trypanisma* Clemens from which it differs as follows: In *Trypanisma* vein 8 of the hind wing is fused with the base of 7, forming an accessory basal cell, but in *Darlia* the two are connected (basally) by a short crossvein only (compare Figs. 2*a* and 3). The gnathos of *Trypanisma* is a weak, short hook, but that of *Darlia* is a thick, strong process. The close relationship of the two genera appears obvious.

Darlia praetexta, n. sp.

Alar expanse 10–11 mm.

Labial palpus sordid white heavily overlaid outwardly with grayish fuscous. Antenna grayish fuscous; scape narrowly annulated with sordid white distally. Head sordid white mixed with grayish fuscous. Thorax and forewing grayish fuscous, the former considerably paler posteriorly; near middle of wing, dorsad, a large sordid-white spot; from costa, near apex, a sordid-white transverse outwardly angulate fascia extends to center, thence inwardly angulate to tornus; this fascia is sometimes incomplete and consists of costal and tornal spots; on some specimens, dorsally from base of wing to the light median spot; is a pale brownish shade; cilia concolorous with forewing, somewhat lighter dorsally. Hind wing light shining gray; cilia pale yellowish fuscous; on upper surface, at base, a conspicuous yellowish hair pencil in male, in female reduced to a few spreading hairlike scales. Legs sordid white, strongly overlaid with grayish fuscous outwardly; tarsi annulated with grayish fuscous. Abdomen fuscous above, paler beneath.

Male genitalia.—As figured. The posterior surface of the gnathos, distad, is studded with small spines. Aedeagus short and stout.

Female genitalia.—As figured. Signum a large sclerotized plate.

Type.—U.S.N.M. no. 59423.

Type locality.—Tigre, Argentina.

Remarks.—Described from the type ♂, 2 ♂, and 2 ♀ paratypes, all from the same locality and reared by Fernando Bourquin. Dates are as follows: Type, "V.39"; paratypes, 2 ♂♂, ♀, "VII. 39," ♀, "VI.39." Paratypes in U. S. National Museum and Mr. Bourquin's collection, Buenos Aires.

The life history will be published by Mr. Bourquin.

Gnorimoschema cestrivora, n. sp.

Figs. 4–4*d*

Alar expanse, 15–19 mm.

Labial palpus light buff; second segment with a blackish basal spot and a large subterminal blotch of the same color outwardly and in the brush; third segment with black basal and subterminal annuli. Antenna light ochraceous-buff with four blackish annuli, one slightly beyond scape and three in distal fourth. Head, thorax, and ground color of forewing light ochraceous-buff, variously marked with darker streaks and suffusion; base of tegula and forewing blackish fuscous mixed with buckthorn-brown scales, the latter color extending slightly along dorsal margin; from middle of costa to outer two-thirds a narrow black streak; from base of wing a buckthorn-brown longitudinal streak extends to apex, where it merges with the terminal black scaling; tornus suffused with buckthorn brown; cilia yellowish fuscous mixed with white-tipped black scales; underside of forewing fuscous. Hind wing grayish fuscous, slightly darker apically, with fuscous scaling on the underside; cilia yellowish fuscous. Legs light ochraceous-buff banded and suffused with fuscous. Abdomen light buff with sparse blackish scaling both dorsally and ventrally.

Male genitalia.—As figured. Note the broadly expanded terminal end of the upper arm of harpe.

Female genitalia.—Signum absent.

Type.—U.S.N.M. no. 59424.

Type locality.—Tucumán, Argentina.

Food plant.—*Cestrum lorentzianum* Griseb. (forming galls)

Remarks.—Described from the type ♂, 4♂, and 2♀ paratypes, all from the type locality and reared by Kenneth J. Hayward from galls on the food plant. No dates are indicated on the pin labels. Paratypes in the U. S. National Museum and the collection of the Instituto Miguel Lillo, Tucumán, Argentina.

This species is somewhat atypical for the genus having veins 3 and 4 of the forewing closely approximated, the distal end of dorsal arm of the harpe truncate and broadly triangular, and the signum absent, but these characters hardly warrant generic separation.

Gnorimoschema aquilina (Meyrick), from Peru, and *G. plaesiosema* (Turner), from Australia, New Zealand, and the Americas are the most closely allied described species. This species differs from both *plaesiosema* and *aquilina* by the absence of the subquadrate blackish costal patch. In the male genitalia *cestrivora* differs from the other two by the presence of a series of teeth on the aedeagus ventrally. The female of *aquilina* is not known, but the signum of *plaesiosema* is a strong thorn and in *cestrivora* it is absent (atypical for the genus).

ENTOMOLOGY.—*Further notes on the family Paratydeidae (Acarina), with a description of another new genus and species.*[1] Edward W. Baker, Bureau of Entomology and Plant Quarantine.

In a previous paper[2] I described the family Paratydeidae, with the new genus *Paratydeus* as type. Recently, while examining material collected from soil debris by Philip W. Smith and Lewis J. Stannard, of the Illinois Natural History Survey, I found a series of minute mites which proved to belong to a new genus of Paratydeidae. The family was originally described as having no genital suckers, whereas the Illinois material has two pairs. However, the original description was based upon a single female containing an egg directly over the genital area, probably obscuring the suckers which must be present. The family definition is therefore changed to include two pairs of genital suckers and two to four pairs of genital setae. The Illinois specimens belong to a distinct genus, distinguished by the lack of eyes, by having three instead of two transverse body sutures, and by having four pairs of genital and four pairs of accessory setae instead of the two pairs of each as in *Paratydeus*.

In the previous paper the genus *Scolotydaeus* Berlese was regarded as belonging to the Tydeidae, but in view of the discovery of another related genus belonging to the Paratydeidae it is now thought advisable to remove *Scolotydaeus* from the Tydeidae and place it in the Paratydeidae with *Paratydeus* and *Neotydeus*, new genus. The three may be separated as follows.

1. Without eyes 2
   With eyes .... *Paratydeus* Baker
2. Body divided into 3 portions by 2 transverse sutures .... *Scolotydaeus* Berlese
   Body divided into 4 portions by 3 transverse sutures .... *Neotydeus*, n. gen.

Since *Scolotydaeus* is known only from a brief description, figure, and notes, rediscovery of the genus should add details not now known.

Neotydeus, n. gen.

Prostigmatic, with pseudotracheae as in *Paratydeus;* palpi 4-segmented, without claw-thumb complex and with tarsal segment terminal; cheliceral bases apparently not fused, movable segment short, strongly curved, reaching past tip of degenerate fixed chela; body elongate, propodosoma and hysterosoma without plates, skin striated; hysterosoma divided into three distinct parts by two transverse sutures just behind the posterior coxae; body setae short, lanceolate, slightly serrate, propodosoma with a single pair of long sensory setae, two pairs of short setae, two pairs of lateral peglike setae, no eyes; anal opening on venter at rear; genital opening approaching anal opening, with two pairs of genital suckers, four pairs of genital and four pairs of accessory setae; coxae I-II and III-IV in two widely separated

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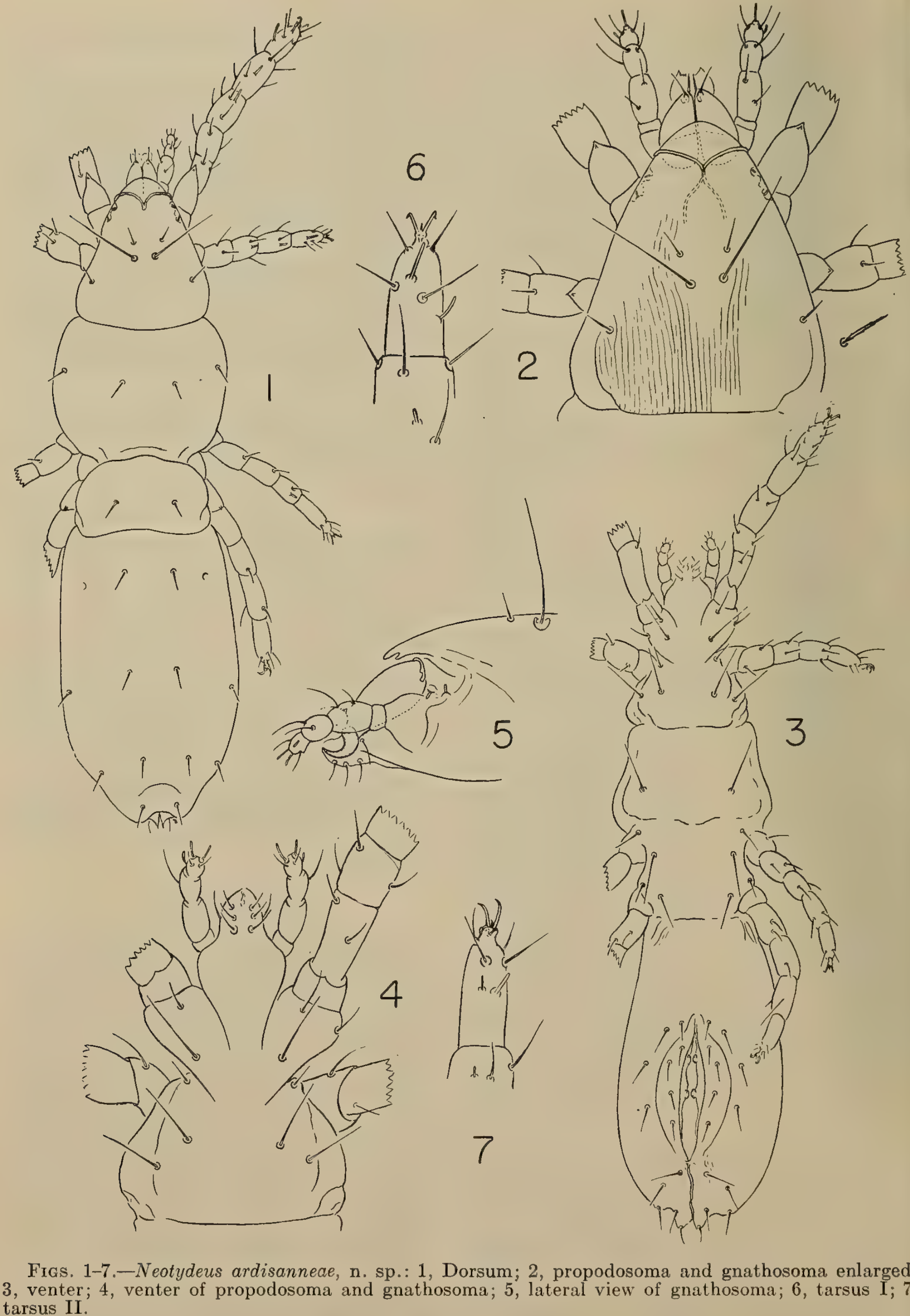
[1] Received June 7, 1950.

[2] Proc. Ent. Soc. Washington **51** (3) 119–122. 1949.



FIGS. 1–7.—*Neotydeus ardisanneae,* n. sp.: 1, Dorsum; 2, propodosoma and gnathosoma enlarged; 3, venter; 4, venter of propodosoma and gnathosoma; 5, lateral view of gnathosoma; 6, tarsus I; 7, tarsus II.

groups; coxae fused with body; legs sparsely haired; tarsi with two claws and a small clawlike pulvillus; tarsus I with two short rodlike setae.

Type.—*Neotydeus ardisanneae*, n. sp.

Neotydeus ardisanneae, n. sp.

Female.—Small, 366μ long; without shields, skin striate; with pseudotracheae as figured (Fig. 2); palpi (Figs. 2, 4, 5) 4-segmented, without claw-thumb complex, segment II with two dorsal setae, segment III with three setae, segment IV terminal, with three terminal rodlike setae, a lateral clublike seta, and four simple setae; cheliceral bases apparently not fused, each with a dorsal distal seta; movable chela (Fig. 5) short, heavy, strongly curved, fixed chela degenerate, not visible; venter of gnathosoma with three pairs of simple setae and a pair of lateral setae (these are the setae described as the lateral cheliceral setae in *Paratydeus alexanderi* Baker); body elongate; propodosoma and hysterosoma (Fig. 1) divided by a transverse suture; propodosoma (Fig. 2) without eyes, with a single pair of long sensory setae, an anterior pair of short simple setae, a lateral pair of serrate setae, two pairs of short lateral, peglike setae above trochanter I; hysterosoma (Fig. 1) divided into three parts by two transverse sutures behind posterior coxae; anterior portion of hysterosoma with a transverse row of four setae, middle section with two setae, and posterior section with six pairs of short setae as figured; anal opening (Fig. 3) on venter at rear; genital opening approaching anal opening, with four pairs of genital and four pairs of accessory setae, and two pairs of genital suckers; coxae in two distinct groups, fused with body; legs with a few short simple setae; all tarsi with a pair of claws and a small clawlike pulvillus; tarsus I (Fig. 6) with two rodlike sensory setae; tibia and genu I each with a single rodlike seta; tarsus, tibia (Fig. 7) and genu II each with a single rodlike seta; tibia III with a similar seta.

Male.—Not known.

Twelve specimens, all females, 1 designated as type and 11 as paratypes, were collected in leaf trash, Sanburn, Johnson County, Ill., on September 20, 1949, by Philip W. Smith and Lewis J. Stannard.

Type.—U. S. N. M. no. 1899. Two of the paratypes are to be deposited in the Illinois Natural History Survey, Urbana, Ill.

The mite is named for my daughter, Ardis Anne Baker.

ZOOLOGY.—*A synopsis of the ostracod genus* Cypricercus, *with a description of one new species from Wyoming.*[1] Willis L. Tressler, College Park, Md.

The fresh-water Ostracoda described as a new species in this report were collected from a moraine pond in the Medicine Bow Mountains of Wyoming in 1936 by Dr. Irving H. Blake, of the University of Nebraska, and were sent to the United States National Museum for identification. The genera *Cypricercus* and *Strandesia* have been somewhat confused in recent years, and as an aid to future workers in the field it has been thought advisable to make a brief synopsis of the known species of *Cypricercus*. These species, which may with certainty be referred to the genus *Cypricercus*, total 19 at the end of the year 1949.

The genus *Cypricercus* was established in 1895 by Georg Ossian Sars to include a South African species, *C. cuneatus* Sars. This form was characterized by the powerfully developed caudal rami and by the spirally coiled spermatic vessels in the male. The genus *Strandesia* Stuhlman (1888) [*Acanthocypris* Claus (1892); *Neocypris* Sars (1901)] is closely allied to *Cypricercus* Sars, and the two have been combined by G. W. Müller (1912) in one genus, *Strandesia*. It was the opinion of Sars and later of Furtos (1933) that these two genera should be kept separate. I concur in this opinion for the following reasons: (1) *Strandesia* appears to reproduce exclusively by parthenogenesis, whereas *Cypricercus* has sexual reproduction; (2) the caudal rami are more powerfully developed in *Cypricercus;* and (3) *Strandesia*, as far as is now known, is restricted to southern regions, whereas *Cypricercus* is found in both northern and southern localities. Sars (1928) has also included several species that had heretofore been included in the genus *Eucypris* and that are now held to be valid and are included in the present paper. Sharpe (1903,

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[1] A contribution from the Zoology Department of the University of Maryland. Received May 25, 1950.

1908) described two new species for which he established the genus *Spirocypris*. These forms were characterized by spirally coiled spermatic vessels and unquestionably belong to the genus *Cypricercus*.

In the present synopsis I have attempted the use of the little-known formula-type key. According to Edmondson (1949) the formula-type key was invented by J. F. Meyers and was first published by Wulfort (1938) as a key for the rotifer genus *Cephalodella*. Edmondson (1949) published a formula key for the rotifer genus *Ptygura* and discussed the advantages and disadvantages of this type of key as compared with dichotomous and indented keys such as are commonly used. Edmondson gave complete directions for the preparation of formula keys in his publication. The formula key seems to be ideally adapted for use with Ostracoda.

In using the key to identify a specimen, examine the list of characters one by one, writing down the numbers of the statements that are found to be true of the specimen at hand. Strongly developed or unique characters are printed in boldface numbers. The resulting formula is then compared with the list of formulae for known species until one is found that agrees with that describing the unknown specimen. By referring to the literature cited, identification may be made positive by comparison with drawings and complete descriptions. The number in parentheses immediately preceding the species name is the number of the publication that clearly figures and describes the species in question.

The slide of the dissected specimen, from which the description of the new species reported on in this paper was made, has been deposited as a type specimen in the United States National Museum.

Genus **Cypricercus** Sars, 1895

Cypricercus Sars, Skr. Vidensk. Christiania, no. **8**: 37. 1895.

Neocypris Sars, Arch. Naturv. Christiania **24**(1): 29. 1901.

Spirocypris Sharpe, Proc. U. S. Nat. Mus. **26**: 981. 1903.

Strandesia G. W. Müller, Das Tierreich **31**: 186. 1912.

Cypricercus Sars, Crust. Norway **9**: 117. 1928.

Valves elongated, moderately compressed to tumid, higher in front than behind. Left valve projects slightly beyond right in front. Third masticatory process of maxilla with two well-developed spines. Furcal ramus long and slender but not so powerfully developed as in *Strandesia*. Reproduction by sexual means; the testis is coiled in the anterior valve chamber. Terminal claw of furca equal to about half the length of the ramus.

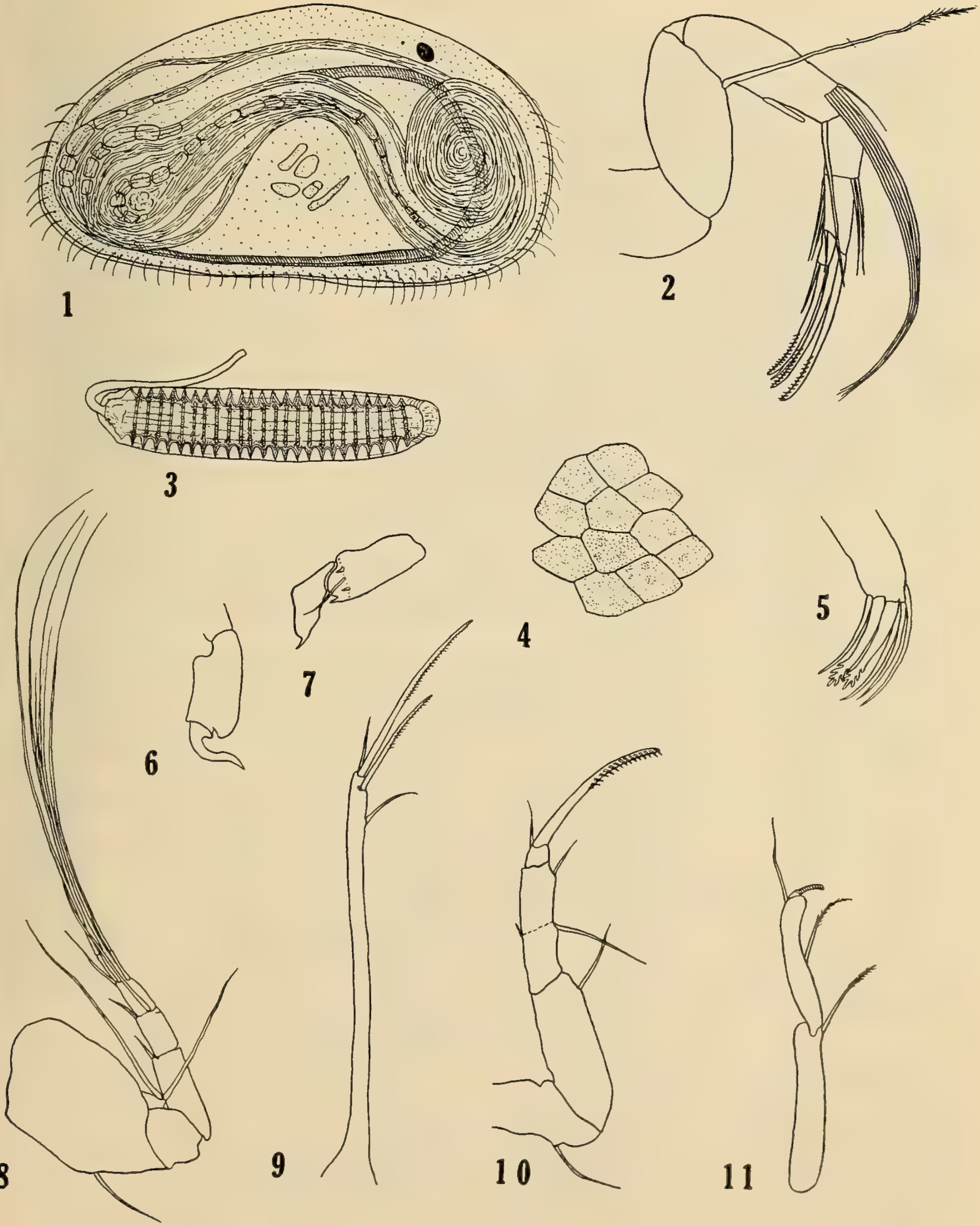
Cypricercus serratus, n. sp.

Figs. 1–11

Specific characters.—MALE from the side: Height equal to about five-ninths the length, highest in the middle, well arched dorsal margin, anterior end extremely broadly rounded, posterior end less so, ventral margin slightly sinuated in the middle, hyaline margins narrow with a few scattered hairs. From above: Moderately compressed, left valve extends beyond right in front. Surface of valves smooth, with very few hairs; a few scattered polygonal markings. Testis with marked spiral coil in anterior valve chamber connected to four bands and U-shaped coils in posterior chamber. Natatory setae of second antennae reach to tips of terminal claws. Maxillary spines heavily toothed. Prehensile palps, unequally developed, the right with propodus twice as long as greatest distal width, dactylus enlarged dorsally; left palp with propodus cylindrical, twice as long as wide, dactylus short and hook shaped. Terminal claw of first leg short and well developed with heavy spines along its distal half. Second leg typical for the genus. Furcal ramus long, slender and slightly curved; length 25 times the narrowest width, dorsal margin smooth; terminal claw equal to about half the length of the furca; terminal seta one-third the length of the terminal claw; dorsal seta slightly longer than terminal seta and removed from subterminal claw by about 1½ times the width of the ramus. Ejaculatory duct long and cylindrical, with 24 whorls. Length 1.08 mm, height 0.69 mm.

FEMALE: Unknown.

Occurrence.—Type locality, Medicine Bow Mountains, Wyo. (moraine pond), at an altitude of 10,200 feet. Two males were taken by Dr. Irving H. Blake on July 4, 1936. Holotype, U. S. N. M. no. 90739.



FIGS. 1-11.—*Cypricercus serratus*, n. sp.: 1, Lateral view, male; 2, second antenna, male; 3, ejaculatory duct, male; 4, surface markings on valve, male; 5, masticatory process of maxilla, male; 6, left prehensile palp, male; 7, right prehensile palp, male; 8, first antenna, male; 9, furcal ramus, male; 10, first thoracic leg, male; 11, second thoracic leg, male.

KEY

CHARACTERS

1. Surface of valves smooth, delicately haired.
2. smooth, densely haired.
3. with wartlike tubercles or spines, few hairs.
4. with wartlike tubercles or spines, densely haired.
5. with raised network of reticulations.
6. Length of valves greater than 1.00 mm.
7. less than 1.00 mm.
8. Ejaculatory duct of male with less than 30 whorls.
9. with 30 or more whorls.
10. Natatory setae of second antennae reaching to tips of claws or beyond.
11. not reaching to tips of claws.
12. Furcal ramus straight.
13. curved or S-shaped.
14. Spines on third maxillary process smooth.
15. toothed or denticulated.
16. Terminal claw of furcal ramus less than one-half length of ramus.
17. at least one-half length of ramus.
18. Terminal seta of furcal ramus less than one-half length of terminal claw.
19. greater than one-half length of terminal claw.
20. Prehensile palps of second thoracic leg equally developed.
21. unequally developed.

FORMULAE

1-6-8-10-13-15-17-18-21		*serratus* Tressler, 1950. Length 1.36 mm; height 0.69 mm., moraine pond, 10,200 feet elevation, Wyoming.
1-6-8-11-15	(7)	*episphaena* Müller, 1908. Length 1.60 mm; height 0.65 mm. Africa, Brazil.
1-6-9-13-15-16-18-21	(3)	*dentifera* Dobbin, 1941. Length 2.00 mm; height 1.04 mm. Pond, Washington.
1-6-9-13-16-18-21	(9)	*cuneatus* Sars, 1895. Length 1.60 mm; height 0.70 mm. Africa.
1-6-10-13-15-17-18	(16)	*rotundus* Tressler, 1950. Length 1.08 mm; height 0.63 mm. Lakelet, Brazil.
1-6-10-13-17-18	(3)	*elongata* Dobbin, 1941. Length 1.82 mm; height 0.78 mm. Ponds, lakes, Washington.
1-6-10-13-17-19-21	(3)	*columbiensis* Dobbin, 1941. Length 1.27 mm; height 0.60 mm. Pond, Washington.
1-6-10-15-16-18	(12)	*obliquus* (Brady, 1866. Length 1.26 mm; height 0.70 mm. Europe.
1-6-10-15-17-18	(12)	*affinis* (Fischer), 1851. Length 1.20 mm; height 0.67 mm. Europe, Ohio, Illinois, Mexico, Alaska, Ontario.
1-6-13-15-16-18	(7)	*maculatus* Müller, 1908. Length 1.50 mm; height 0.67 mm. Africa.
1-7-8-10-13-15-16-18-21	(6)	*mollis* Furtos, 1936. Length 0.80 mm; height 0.44 mm. Florida.
2-6-10-17-19	(13)	*passaica* (Sharpe), 1903. Length 1.60 mm; height 0.80 mm. Massachusetts, New Jersey.
2-6-11-14-16-18	(12)	*hirsutus* (Fischer), 1851. Length 1.10 mm; height 0.55 mm. Sweden, Russia, Pribilof Islands.
3-6-8-10-13-15-17-18-21	(5)	*tincta* Furtos, 1933. Length 1.50 mm; height 0.90 mm. Ohio, Michigan.
3-7-10-16-18	(14)	*tuberculatus* (Sharpe), 1908. Length 0.93 mm; height 0.53 mm. Illinois, Indiana.
4-6-9-10-13-15-17-18-21	(5)	*splendida* Furtos, 1933. Length 1.75 mm; height 0.80 mm. Ohio, Massachusetts, New York.
4-6-10-12-16-18	(11)	*horridus* Sars, 1926. Length 1.05 mm; height 0.57 mm. Ontario.
4-6-11-15-17-18	(12)	*fuscatus* (Jurine), 1820. Length 1.50 mm; height 0.82 mm. Europe, Illinois, Ohio, Georgia, Delaware, Massachusetts.
5-6-12-19	(2)	*reticulatus* Daday, 1898. Length 1.30 mm; height 0.68 mm. Ceylon, Illinois, Virginia, Maryland.

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ZOOLOGY.—*A new species of the gorgonacean genus* Ainigmaptilon *Dean* (*Coelenterata: Octocorallia*).[1] Frederick M. Bayer, U. S. National Museum.

Carlgren (1943) has recently published a study of the peculiar octocorallian genera *Ainigmaptilon* Dean and *Lycurus* Molander, in which he reached the conclusion that the two are identical, with Dean's name taking precedence. At the same time he described the new species *Ainigmaptilon wallini*, bringing the number of known forms to four. He also was of the opinion that the genus should be treated as a special family rather than as a subfamily of the Primnoidae as proposed by Molander (1929), and with this view I thoroughly agree. A very distinct new species of *Ainigmaptilon*, which presents additional evidence that Carlgren's interpretation is correct, was collected for the Smithsonian Institution by Cmdr. David C. Nutt during the U. S. Navy Antarctic Expedition, 1947–48.

Family Ainigmaptilidae Carlgren, 1943

Lycurinae Molander, 1929, p. 70.
Ainigmaptilonidae Carlgren, 1943, p. 7.

Diagnosis.—Gorgonaceans with more or less strongly calcified horny axis; polyps borne on expanded, unsupported, simple or branched "polyp-leaves"; spicules as thin scales; operculum developed.

Genus **Ainigmaptilon** Dean

Ainigmaptilon Dean, 1926, p. 337; Carlgren, 1943, p. 1.
Lycurus Molander, 1929, p. 66.

As has been pointed out independently by the authors of both names for this genus, *Ainigmaptilon* bears a striking superficial resemblance to certain pennatulids: the polyps are carried on biserial, leaflike, branched or unbranched lateral outgrowths without axial support, as in *Virgularia*. This pennatulidlike effect was heightened, in the first specimen described, by the absence of a horny axis (which had probably been torn out when the colony was dredged from the bottom). In spiculation, however, members of this genus clearly show affinity with the Primnoidae. The sclerites are thin scales, and the polyps have an operculum of eight specialized circumtentacular scales. The polyp body-scales are either arranged more or less clearly in eight longitudinal rows, or are irregularly scattered. The axis is strongly calcified and iridescent, at least in the new species here described. The stem terminates proximally in a funnel-shaped expansion which, when filled with mud, must serve as an effective anchor. This feature has been carefully described by Carlgren (1943, p. 2) for *A. wallini;* the rootlike base of *A. virgularoides* described by Molander (1929, p. 66) is also thought by Dr. Carlgren to be the remains of a funnel-like base. A well-formed funnel is present in *A. edisto*, n. sp., and it seems likely that a similar modification of the base occurs also in the other species.

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received May 25, 1950.

Type (by monotypy).—*Ainigmaptilon haswelli* Dean.

Distribution.—Antarctic and Subantarctic, circumpolar: *A. haswelli* was taken at 66° 55′ South, 145° 21′ East, off King George V Land (512–549 m); *A. wallini* in the Ross Sea, near Discovery Inlet (550 m); *A. antarcticum* and *A. virgularoides* at lat. 64° 36′ S., long. 57° 42′ W., off Snow Hill Island (125 m) and the latter also at lat. 54° 17′ S., long. 36° 28′ W., off South Georgia (75 m); and *A. edisto*, n. sp., at lat. 65° 25′ S., long. 101° 13′ E., off Queen Mary Land (182 m).

Ainigmaptilon edisto, n. sp.

Diagnosis.—Colony unbranched; proximal end of stem furnished with a funnel-shaped expansion; axis heavily calcified, round, irregularly grooved longitudinally, light yellowish with pearly iridescence. Polyps borne on broad, bifid polyp-leaves which are opposite on the stem, in two lateral rows; opercular scales oval, with a very long, slender, smooth distal spine; no differentiated marginal (circumopercular) scales; body scales irregular, elongate, arranged longitudinally but not in eight rows. Coenenchyma of polyp leaves and stem densely packed with elongate, irregular scales.

Description.—The type (Fig. 1), a unique specimen, is broken; it consists of the base and lower part of a colony, 200 mm in length, together with 80 mm of naked axis (lacking the distal tip), and the apical 15 mm of the colony (lacking the axis);

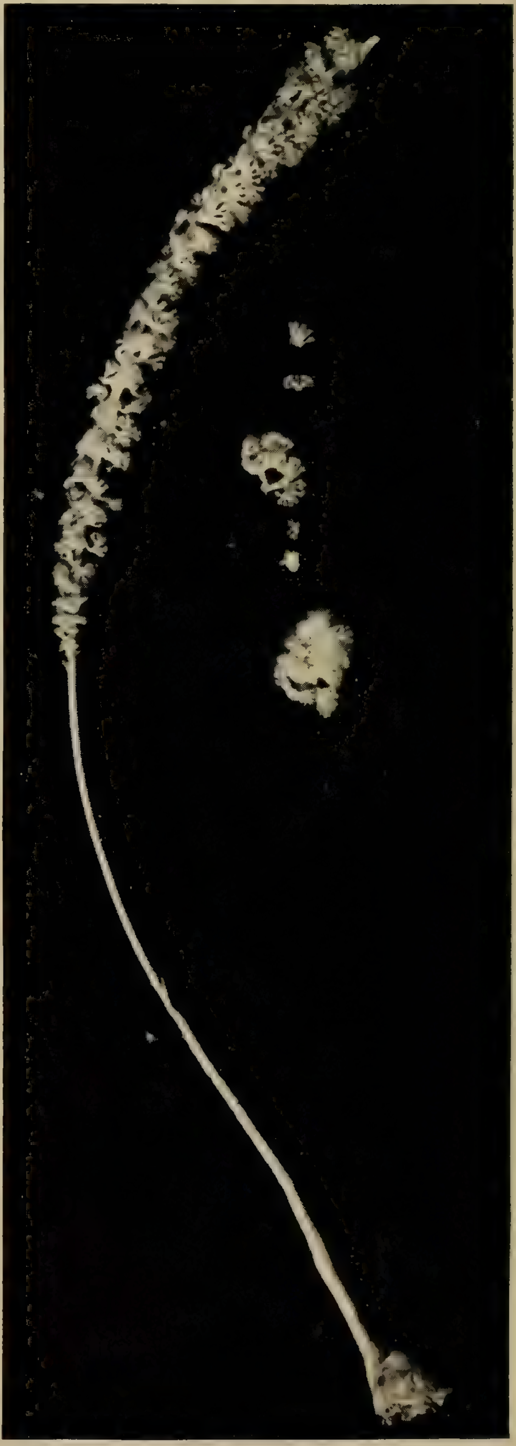

FIG. 1.—*Ainigmaptilon edisto*, n. sp.: The type specimen, about natural size. (Smithsonian Institution photograph.)

the entire colony must therefore have measured something over 295 mm in length. The polyp-leaves, which begin about 105 mm from the base, are opposite, in two series which incline a little toward one side of the axis. The leaves of the four proximal pairs are indistinctly bifid, and the polyps are placed along their free margins in a single row. The leaves of the more distally placed pairs are clearly bilobed (Fig. 2, *f*), with the polyps arranged along their free margins in two more or less distinct rows, usually numbering ±15 on each lobe. On the leaves in the distal third of the colony, extra polyps are intercalated between the two marginal rows, increasing in abundance on the more distally situated leaves until, in the terminal 15 mm, all the leaves have three rows and sometimes the beginning of a fourth. The polyps themselves (Fig. 2, *e*) are 2.5 to 3.0 mm tall from base to tip of opercular scales. The opercular spicules are well differentiated, elongate oval scales with irregularly dentate margins, sculptured with small warts, and furnished with an extremely long, smooth distal spine (Fig. 2, *a*). The body scales are irregular, elongate, finely warted but with a border practically devoid of sculpture (Fig. 2, *b*); they are arranged longitudinally, not in eight rows, closely and irregularly packed. Sclerites of similar form are found

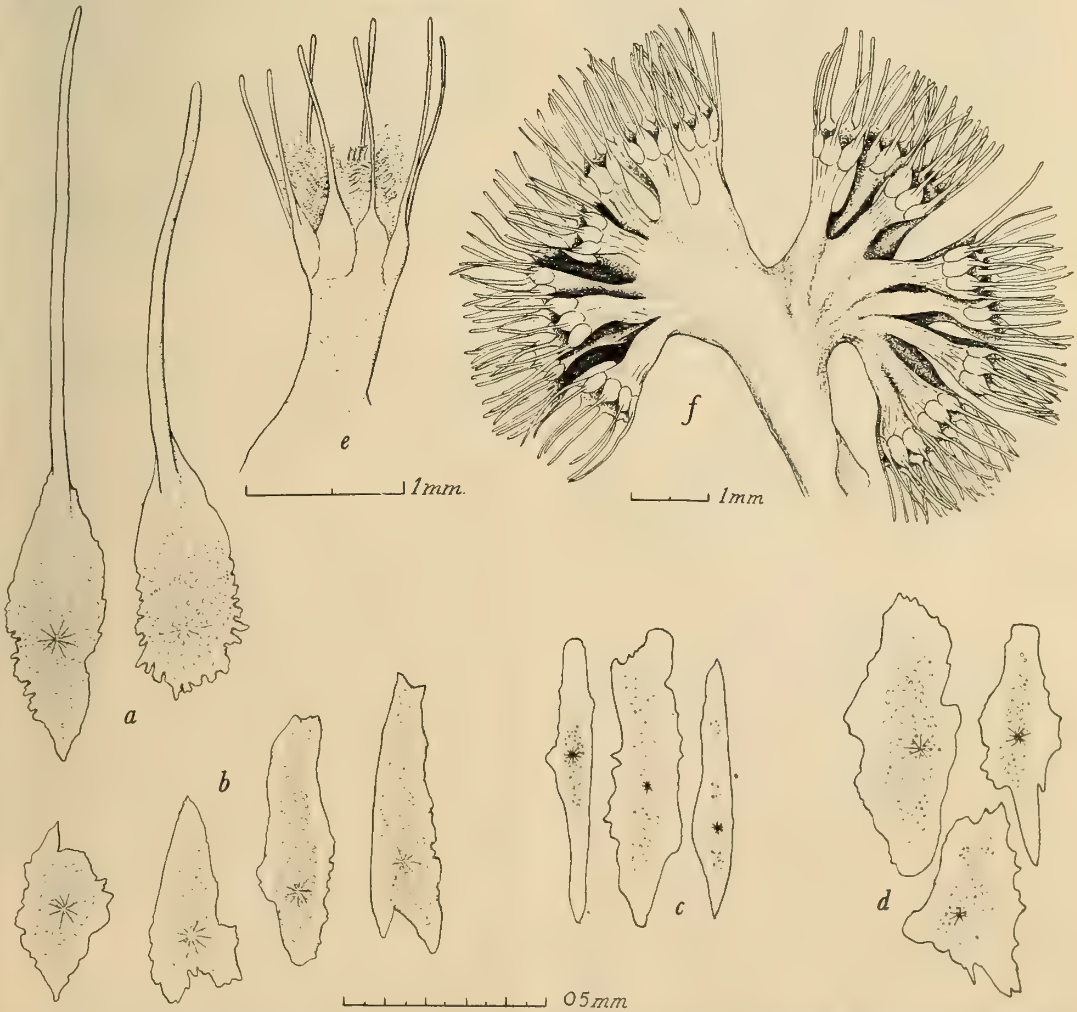

FIG. 2.—*Ainigmaptilon edisto*, n. sp.: *a–d*, Spicules (*a*, two operculars; *b*, four body scales; *c*, three scales from a polyp-leaf; *d*, three scales from the stem rind); *e*, single zooid; *f*, polyp-leaf from above the middle of colony, showing two rows of zooids on the right lobe, and an incomplete third row on the left lobe.

thickly set in the walls of the polyp-leaves (Fig. 2, *c*) and in the stem rind (Fig. 2, *d*). The color of the colony is cream white.

Type.—U. S. N. M. no. 49580.

Locality.—Lat. 65° 25′ S., long. 101° 13′ E., 100 fathoms; water temperature (surface) 30° F.; January 14, 1948, collected by Cmdr. D. C. Nutt, U. S. N. R., abroad the U. S. S. *Edisto*.

KEY TO THE KNOWN SPECIES OF AINIGMAPTILON

1. Polyp-leaves simple.
Ainigmaptilon virgularoides (Molander)
Polyp-leaves subdivided or branched....... 2
2. Opercular scales with prominent apical spine 3
Opercular scales more or less acutely pointed but without a long projecting spine....... 4
3. Opercular scales strongly sculptured with thorns; apical spine stout, prominently thorny........*Ainigmaptilon haswelli* Dean
Opercular scales sculptured with small warts; apical spine very long, slender and smooth.
Ainigmaptilon edisto, n. sp.
4. Opercular scales more or less regular isosceles triangles; stem rind and all surfaces of polyp-leaves filled with sclerites.
Ainigmaptilon wallini Carlgren
Opercular scales oval-triangular, with bluntly pointed apex; polyp-leaves with spicules only around base and on under surface; stem rind with very few spicules.
Ainigmaptilon antarcticum (Molander)

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ZOOLOGY.—*A new genus proposed for* Lichomolgus major *Williams (Copepoda, Cyclopoida)*.[1] MILDRED STRATTON WILSON, Anchorage, Alaska. (Communicated by Fenner A. Chace, Jr.)

Examination of newly collected specimens of the peocilostome cyclopoid copepod *Lichomolgus major* Williams has led to the conclusion that it constitutes the type of a genus widely separated not only from *Lichomolgus* but also from *Myicola*, to which it has been referred by C. B. Wilson (1932) and subsequent authors. The following new genus is therefore proposed to include this species.

Myocheres, n. gen.

Diagnosis.—Body not fleshy or inflated; sexual dimorphism not pronounced; metasome of five distinct segments, the cephalic and first thoracic segments united. Urosome of four segments in the female, of five in the male; genital segment of female sometimes indistinctly divided, the genital openings lateral, eggs small and numerous. Caudal rami well developed, distinguished in both sexes of the genotype by a stout, elongate, inner apical spine. Rostrum nongeniculate. Antennule 6-segmented. Antenna subprehensile, 4-segmented, the fourth segment offset laterally, and armed with long setae; clawlike spines borne on the produced portion of the third segment.

The oral area with a rather thick prominent labrum having its posterior edge produced medially rather than incised as in the Lichomolgidae; and a much thinner labium formed of two broad, juxtaposed lobes whose posterior edges are curved under and united dorsally. The mandible very reduced in size, its base roughly quadrangular in shape; the apex knoblike, posteriorly directed, armed with a small terminal claw and two posterolateral accessory pieces, the dorsal of which is a long, flat seta. Paragnaths present below the mandibles. The first maxilla arising from the ventral face near the base of the mandible, from which it is clearly distinct in both early copepodid forms and adult; a small, single segmented, sinuous structure, having a few setae arranged in two groups, thus suggesting a bilobed condition. The second maxilla with a very large, inflated, thinly integumented, basal segment, bearing a simple apical claw. Maxilliped absent in the adult female; that of the male of the lichomolgid type, with two basal segments and a long, curving, terminal claw.

Legs 1–4 of normal cyclopoid structure, with very enlarged basipods, both rami 3-segmented; the armature of the second endopod of the male modified in the genotype. Leg 5 well developed, 2-segmented, the apical segment armed with two lateral outer spines, and a stout terminal spine accompanied by a slender seta; the armature of the male differing a little from that of the female.

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[1] Received July 16, 1950.

Both sexes commensal in the mantle cavity of pelecypod Mollusca.

Genotype.—Myocheres major (Williams), n. comb.

Myocheres major (Williams), n. comb.

Lichomolgus major Williams, 1907: 77, pl. 3.
Myicola major, C. B. Wilson, 1932: 347, fig. 208, a-c; Monod and Dollfuss, 1934: 316.
Myicola spinosa, Pearse, 1947: 5, figs. 26–31.

A detailed description of both adult and development forms of the genotype, based upon Canadian specimens and topotypes from Rhode Island, is in preparation and will be published in the near future. This will include also a discussion of the genus *Myicola*, the systematic position of both genera and of other species that have been erroneously ascribed to *Myicola*, with a redescription of the type, *Myicola metisiensis* R. R. Wright.

Both *Myocheres* and *Myicola* are found in the common clam, *Mya arenaria*. I am indebted to Dr. J. C. Medcof, of the Fisheries Research Board of Canada, and to Dr. Fenner A. Chace, Jr., of the United States National Museum, for collections made of both of these genera. In addition, the collection upon which Pearse (1947) based his paper on the molluscan parasites from the Beaufort region has also been available. From the study of these it has been possible to establish the synonymy of *Myicola spinosa* and *Myocheres major*.

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MAMMALOGY.—*Two new shrews of the genus* Cryptotis *from Panama.*[1]

HENRY W. SETZER, U. S. National Museum.

Three specimens of shrews from Chiriquí Province, Republic of Panama, referred to the United States National Museum for identification have been found to be hitherto undescribed. Two of the specimens were obtained by Dr. Eric Graetz and presented by James Zetek; the other specimen was obtained by Dr. R. K. Enders. I am indebted to Dr. H. Radclyffe Roberts, of the Academy of Natural Sciences of Philadelphia for the privilege of examining and describing the Enders specimen.

Capitalized color terms are from Maerz and Paul, *A dictionary of color* (1930). Measurements are in millimeters.

These new shrews may be known as:

Cryptotis zeteki, n. sp.

Type.—Female, adult, U.S.N.M. no. 290466; Cerro Punta (lat. 8°42′ N., long. 82°48′ W.), 6,500 feet, Chiriquí Province, Republic of Panama; obtained in April 1949 by Dr. Eric Graetz, presented by James Zetek. (Specimen in alcohol from which the skull has been removed and cleaned.)

Range.—Known only from the type locality.

Diagnosis.—Entire dorsal surface Mummy Brown, no appreciable lightening on sides or belly; hands and feet whitish; tail lighter than dorsal coloration. Skull: Dorsal surface, above posterior margin of palate, but slightly concave; canines but slightly procumbent; maxillary toothrow, especially unicuspid series, crowded until fourth unicuspid is forced out of toothrow medially; rostrum short and relatively wide; teeth but lightly pigmented.

Comparisons.—Cryptotis zeteki differs from *C. jacksoni* from Volcán Irazu, Costa Rica, in somewhat smaller size, especially the tail and hind foot; somewhat lighter in color; skull smaller in all measurements taken with the exception of the width of M^1, which is wider; unicuspid series more crowded; all teeth less pigmented; parietal sloping more anteriorly; entire rostrum shorter and slenderer.

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[1] Received June 21, 1950.

From *Cryptotis merus*, from Mount Pirre, Panama, *C. zeteki* differs in lighter color, especially the hands and feet which are very pale; skull smaller in all measurements taken; brain case less inflated; unicuspid series more crowded; skull less concave above orbits; anterior teeth less procumbent. The two species are about the same size.

C. zeteki differs from *Cryptotis gracilis* from head of Lari River, Pico Blanco, Costa Rica, as follows: Color lighter in all respects, especially the hands and feet; skull smaller in most measurements taken; zygomatic width, width of M^1, and width of M^2-M^2 all greater; rostrum shorter and wider; unicuspid series more crowded; brain case less inflated; teeth less pigmented. The two are about the same size.

C. zeteki differs from *Cryptotis nigrescens* from Tablazo, Province of Cartago, Costa Rica, in smaller size; lighter color, including the hands and feet and in the extreme reduction of the fourth unicuspid, which, in *C. nigrescens* is still retained in the toothrow.

From *Cryptotis orophila* from Estrella de Cartago, Province of Cartago, Costa Rica, *C. zeteki* differs in uniformly darker color; more crowded toothrow; and narrower, shorter rostrum.

Measurements.—The type measures as follows (external measurements from alcoholic specimen): Total length 83; length of tail 22; length of hind foot 11; length of upper toothrow entire 8.3; zygomatic width 5.7; greatest length of skull 18.5; greatest width of skull 8.9; width of M^1 1.7; condylobasal length 18.1; width across M^2-M^2 5.0.

Remarks.—This shrew, as may be noted from the comparisons, is readily distinguishable from all other shrews from Central America by means of the extremely crowded unicuspid series.

Cryptotis zeteki appears to be most closely related, morphologically, to *Cryptotis nigrescens* from Costa Rica.

Both the type and paratype were taken by Dr. Graetz at Cerro Punta as a result of land clearing by the natives of that area.

Specimens examined.—Two, both from Cerro Punta.

Cryptotis endersi, n. sp.

Type.—Adult, skin and skull, no sex given on original label, Acad. Nat. Sci. Philadelphia no. 20955; Cylindro, Province of Chiriquí, Panama; obtained July 24, 1941, by R. K. Enders, original number 3310.

Range.—Known only from the type locality.

Diagnosis.—Entire dorsal surface Chaetura Black, no appreciable lightening on sides or belly; hands and feet blackish; tail of same color as dorsum. Dorsal surface of skull concave above orbits; rostrum long and narrow; maxillary toothrow relatively straight and uncrowded; fourth unicuspid visible in lateral view; teeth rather heavily pigmented.

Comparisons.—From *Cryptotis zeteki*, *C. endersi* differs in larger size; darker color; and longer, straighter toothrow. In all cranial measurements *C. endersi* is noticeably larger.

From *Cryptotis jacksoni*, *C. merus*, *C. gracilis*, and *C. orophila*, *C. endersi* may be distinguished by its larger size and larger skull.

From *Cryptotis thomasi*, *C. endersi* is somewhat smaller in body size and smaller in all cranial measurements taken; noticeably in the greatest width of the skull and in the length and width of the rostrum.

From *Cryptotis meridensis*, *C. endersi* is smaller in all respects, particularly in cranial measurements, in the length and width of the rostrum and the greatest width of the skull.

Measurements.—The type measures as follows: Total length 109; length of tail 36; length of hind foot 12; length of upper toothrow entire 9.4; zygomatic width 6.2; greatest length of skull 21.2; greatest width of skull 9.8; width of M^1 1.7; condylobasal length 20.2; width across M^2-M^2 5.7.

Remarks.—The type of *C. endersi* was taken in heavy forest near a rotting log by Dr. Enders in the course of zoological field work in the Chiriquí section of Panama. Morphologically, this shrew is nearest *Cryptotis meridensis* from Colombia, although the two species may be distinguished by the characters set forth under comparisons.

Latin American shrews appear to fall into two main groups, on the basis of their dental pattern. *Cryptotis meridensis* can be considered rather typical of the larger, straighter toothrow kind and *Cryptotis nigrescens* of the smaller, angular toothrow group. Additional specimens, and in particular a series of one kind from any given locality, are needed in order to define the amount of variation obtaining in shrews from Central and South America.

Specimen examined.—One, the type.

ORNITHOLOGY.—*A new race of* Parus sclateri *from the Sierra Madre del Sur of Mexico.*[1]

Alden H. Miller, Museum of Vertebrate Zoology, University of California, and Robert W. Storer, Museum of Zoology, University of Michigan. (Communicated by H. G. Deignan.)

In the Milton S. Ray collection of birds from Guerrero, Mexico, is an excellent series of *Parus sclateri* from the Sierra Madre del Sur of that state. These at once impressed the late Mr. Ray and the senior author as distinctly more yellowish or buffy in color than *Parus sclateri* as known from the mountains surrounding the Central Plateau of Mexico. Aware of the many chances for misinterpretation of these color differences in chickadees owing to make of skin and museum age of specimen, we have made particular effort to assemble and examine all available specimens and to make comparisons between birds taken at the same time of year and in the same period of years. Further need for careful weighing of the differences was emphasized by Traylor's (Fieldiana, Zool., **31:** 272. 1949) recent inability to discern color differences between *P. s. sclateri* and *P. s. eidos* of Arizona.

A large part of the material available of this species consists of badly worn birds taken in the breeding season (April to July), poorly plumaged juveniles, or inadequately prepared specimens. Such material is essentially useless for meaningful color comparisons, which need to be carried out on fresh-plumaged birds taken in the period from September to December. Among specimens taken in the latter period, we see very little evidence of alteration in color with museum age. For example, birds taken from the vicinity of the Valley of Mexico before 1900 are essentially the same as those taken there in the past 10 years, the change, if any, being toward olive and away from purer gray in the older material. The Guerreran series has been taken in the past 13 years, but chiefly from 1941 to 1947, and its olive and yellow color would, accordingly, be expected to be at a minimum and to reflect closely the inherent condition of the birds. Moreover, the Guerreran skins, excellently prepared by W. W. Brown, have been compared with some typical *sclateri* prepared by the same collector.

We conclude therefore that the extremely yellowish and olive color of the Guerreran chickadees is a natural attribute of these birds and warrants description of them as—

Parus sclateri rayi, n. subsp.

Type.—Male, Mus. Vert. Zool. no. 111910, taken at Omilteme, Guerrero, Mexico, October 30, 1944, by W. W. Brown.

Diagnosis.—Similar to *Parus sclateri sclateri*, but breast Ivory Yellow rather than whitish and flanks between Grayish Olive and Olive Buff rather than Deep Olive Gray. Back often Grayish Olive and Deep Grayish Olive rather than Mouse Gray and Deep Olive Gray (capitalized color names are those of Ridgway).

Range.—Resident of the Sierra Madre del Sur in Guerrero, extending eastward into Oaxaca; also the vicinity of the Volcán de Colima in extreme southwestern Jalisco.

Specimens of P. s. rayi *examined.*—Omilteme, Guerrero, 5 (July, October, December, Mus. Vert. Zool.); Cuapongo, Guerrero, 7 (March, August, September, November, Mus. Vert. Zool.); Chilpancingo, Guerrero, 3 (March, May, Louisiana State Univ.); Cerro San Felipe, Oaxaca, 1 (August 31, U. S. Nat. Mus.); Sierra Nevada de Colima [Volcán de Colima]. Jalisco, 13 (July, September, Amer. Mus. Nat. Hist.).

The isolation of the range of *P. s. rayi* of the Sierra Madre del Sur of Guerrero from that of *P. s. sclateri* in the mountains of Michoacán, Mexico, Morelos, and Puebla by the valleys of the Río Balsas and the Río Tepalcatepec may be presumed to be a factor in maintaining and perhaps also developing the racial differences noted. To the eastward there would appear to be a possible connection of populations of this high-zone species in southern Puebla and northern Oaxaca. The single example of *rayi* from Oaxaca seems properly allocated to this race but it is not an extreme example of it; an adequate representation of the species from Oaxaca should be examined in order better to establish the range of this form in that state.

The occurrence of *rayi* in the vicinity of the Volcán de Colima is unexpected on geographic grounds. The area is close to the Pacific coast as

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[1] Received June 7, 1950.

is the Sierra Madre del Sur, but it is separated from that sierra by the lower Balsas Valley and is connected northeastward with the highlands of Michoacán, although the connection of chickadee habitat in that direction may be tenuous. The specimens from the Volcán de Colima are distinctly yellower than the birds of Michoacán, however, and although taken in 1905, are much yellower and more olive than even older fall-taken specimens from the state of Mexico. They seem to show less of the grayish element in the yellow and olive areas than the Guerreran specimens, but we suspect this difference is due to the museum age of the skins.

The most distinctive features of *rayi* are the olive and buff hues of the underparts. Some *P. s. sclateri* approach but do not quite equal the less extreme examples of *rayi* in this respect. The juvenal plumages of the two are not fully differentiated. The differentiation in back color of the two races is not as complete as that of the ventral coloration and alone it would permit separation of little more than 50 percent of the individuals from the ranges of the two subspecies.

Dimensions of *Parus sclateri* reveal slight geographic differences suggesting a cline of increasing size northward from the Orizaba district into the race *eidos*. However, *rayi* does not seem to be significantly different from *P. s. sclateri* in this respect.

Although it is not in the province of this paper to report at length on the status of *P. s. eidos*, we do note that fresh-plumaged material of *eidos*, which we have in abundance, contrasts with topotypical material of *P. s. sclateri* from the Orizaba district and with *sclateri* from the vicinity of Mexico City in the paler, less olivaceous color of the flanks and back. The greater amount of white beneath in *eidos* is difficult to ascertain where varying makes of skin are involved, but we think this character of less significance than the color of the flanks and back. Traylor (*loc. cit.*) may have been unduly concerned with this character in his recent evaluation of *eidos*. In our view, then, *eidos* is a recognizable subspecies showing a degree and consistency of difference found in many geographic races in the Paridae.

We are indebted to the following for the use of specimens: Herbert Friedmann and the United States National Museum, John T. Zimmer and the American Museum of Natural History, George H. Lowery, Jr., and Louisiana State University, Josselyn Van Tyne and the University of Michigan Museum of Zoology, and George M. Sutton. The race of chickadee here described is named in honor of Milton S. Ray, whose extremely valuable collection of birds has become a part of the Museum of Vertebrate Zoology through the generosity of the Ray family.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

New Members of the Academy

There follows a list of persons elected to membership in the Academy, by vote of its Board of Managers, since December 1, 1949, who have since qualified as members in accordance with the bylaws. The bases for election are stated with the names of the new members.

RESIDENT

Elected December 12, 1949

Carl I. Aslakson, commander, U. S. Coast and Geodetic Survey, in recognition of his work in the development of improved methods for surveying field work, the design of charts for the Army Weather Services, and particularly the development of special methods for precise alignment and the application of electronics to the improvement and extension of precise geodetic surveys.

Harold T. Cook, senior pathologist, U. S. Department of Agriculture, in recognition of his contributions to plant pathology and in particular his research on vegetable diseases.

Howard A. Meyerhoff, permanent secretary, American Association for the Advancement of Science, in recognition of his contributions to the geology and physiography of the Western Hemisphere, particularly the geology and paleontology of the West Indies.

John A. O'Keefe, chief, research and analysis section, geodetic division, Army Map Service, in recognition of his development work in mathematics of projections, astronomical-geodetic applications, and geodetic application in guided-missile work.

Douglas L. Parkhurst, chief, instrument division, U. S. Coast and Geodetic Survey, in recognition of his long and productive career in the design and production of scientific instruments, particularly the Parkhurst theodolite.

Donald A. Rice, mathematician, U. S. Coast and Geodetic Survey, in recognition of his excellent work in figure of the earth investigations and leadership in the project being conducted by the U. S. Coast and Geodetic Survey in the determination of the deflection of the plumb line by means of gravity anomalies.

Elected January 23, 1950

James M. Blume, soil scientist, Bureau of Plant Industry, Soils, and Agricultural Engineering in recognition of his contributions to chemical requirements of soils and, in particular, his research on atomic-energy utilization.

Bernice E. Eddy, senior bacteriologist, National Institutes of Health, in recognition of her study of the antigenic relationship of the pneumococcic types, clarification of the nomenclature of the types, and descriptions of many new types; also for developing a method for the standardization of influenza virus vaccine and establishing minimum requirements for the regulation of the sale of influenza virus vaccine.

Churchill Eisenhart, chief, statistical engineering laboratory, National Bureau of Standards, in recognition of his contributions to mathematics, in particular to the techniques of statistical analysis.

Angus M. Griffin, professor of bacteriology, George Washington University, in recognition of his important contributions toward an understanding of the coliform bacteria and his work on the antigenic analysis of red blood cells and of bacteria.

Morley A. Jull, head, poultry department, University of Maryland, in recognition of his research in poultry breeding.

Ernest A. Lachner, associate curator of fishes, U. S. National Museum, in recognition of his life-history studies of eastern United States fresh-water fishes and systematic studies of fresh- and salt-water fishes.

Elizabeth E. Sager, physical chemist, National Bureau of Standards, in recognition of her contributions to chemistry, particularly to absorption spectrophotometry.

Joseph C. Shaw, in charge of dairy-production research, University of Maryland, in recognition of his work on ketosis in dairy cattle.

W. J. Youden, mathematician, National Bureau of Standards, in recognition of his contributions to chemistry and mathematics, and in particular his application of mathematical statistics to the design of experiments and the evaluation of research data.

Elected February 20, 1950

Franz L. Alt, acting chief, computation laboratory, National Bureau of Standards, in recognition of his contributions to applied mathematics.

Victor R. Deitz, physical chemist, National Bureau of Standards, in recognition of his contributions to physical chemistry, in particular to the study of adsorption and adsorbents.

John E. Faber, Jr., head, department of bacteriology, University of Maryland, in recognition of his work on production and preservation of complement.

A. H. Shapley, general physical scientist, National Bureau of Standards, in recognition of his work on the ionosphere and solar activity.

Howard E. Tatel, staff member, Carnegie Institution of Washington, in recognition of his work on the scattering of neutrons by helium and hydrogen, work in cosmic rays at extremely high altitudes with the use of rockets, and work in seismic investigations of the earth's upper crust.

Willis L. Tressler, documents officer, Central Intelligence Agency, in recognition of his significant contributions in the field of systematic zoology, ecology, and limnology.

Elected March 20, 1950

Frank H. Babers, biochemist, Bureau of Entomology and Plant Quarantine, in recognition of his contributions to the chemistry of insecticides and to insect physiology, with special reference to insect resistance to insecticides.

Frederick M. Bayer, assistant curator, division of marine invertebrates, U. S. National Museum, in recognition of his work with the marine animals of the Marshall Islands and of his special studies of invertebrates, particularly the Coelenterata.

Abner Brenner, chemist, National Bureau of Standards, in recognition of his outstanding contributions to the study of the electrodeposition of metals.

O. L. Cartwright, associate curator, division of insects, U. S. National Museum, in recognition of his sustained interest and comprehensive taxonomic studies of the Nearctic Scarabaeidae, particularly the subfamily Aphodiinae.

L. D. Christenson, assistant to the chief, division of fruit insect investigations, Bureau of Entomology and Plant Quarantine, in recognition of his work in economic entomology and military preventive medicine, in particular his studies of the insect transmission of plant diseases and the field control of the vectors of human malaria.

J. A. Duerksen, assistant chief, section of gravity and astronomy, U. S. Coast and Geodetic Survey, in recognition of his research in geodetic astronomy and gravity, particularly in the field of pendulum observations determining dynamic temperature, flexure, and pressure corrections; and deflections of the vertical.

Helen M. Duncan, geologist, U. S. Geological Survey, in recognition of her studies of fossil invertebrate animals, with special reference to the taxonomy of the Paleozoic corals and bryozoans.

Floyd W. Hough, chief, geodetic division, U. S. Army Map Service, in recognition of his development and determination of precise geodetic surveys and particularly for the coordination and readjustment of the European Triangulation.

Paul L. Illg, associate curator, division of marine invertebrates, U. S. National Museum, in recognition of his work with the pharmacology of penicillin and for physiological and taxonomic studies of invertebrate animals, copepod Crustacea in particular.

Edward J. Prosen, senior chemist, National Bureau of Standards, in recognition of his outstanding contributions to thermochemistry and chemical thermodynamics.

Grote Reber, radio physicist, National Bureau of Standards, in recognition of his pioneer work in radio astronomy.

James H. Schulman, head, luminescent materials section, Naval Research Laboratory, in recognition of his work in solid state chemistry and physics, particularly his studies of the luminescence of solids.

Bourdon F. Scribner, chief, spectrochemistry section, National Bureau of Standards, in recognition of his outstanding contributions to applied spectroscopy, especially in the field pertaining to atomic-energy materials.

Henry W. Setzer, associate curator, division of mammals, U. S. National Museum, in recognition of his studies of the distribution and taxonomy of mammals, the kangaroo rats in particular.

C. A. Truesdell, consultant in applied mathematics, Naval Research Laboratory, in recognition of his outstanding contributions to pure and applied mathematics.

James A. Van Allen, physicist, John Hopkins University Applied Physics Laboratory, in recognition of his contributions to nuclear physics, the development of proximity fuzes and particularly for his research on the physics of the upper atmosphere by means of high-altitude rocket studies.

Elected April 17, 1950

William R. Campbell, mechanical engineer, National Bureau of Standards, in recognition of his contributions to engineering mechanics and in particular his researches on the characteristics of wire-resistance strain gauges.

J. H. Curtiss, chief, national applied mathematics laboratories, National Bureau of Standards, in recognition of his contributions to pure and applied mathematics and in particular for his effective introduction of statistical methods in naval engineering and his creation and administration of a strong federal program in applied mathematics.

W. H. W. Komp, sanitary engineer director (entomologist), National Institutes of Health, in recognition of his research on tropical mosquitoes and his outstanding service in the suppression of diseases transmitted by them.

Randall K. Latta, entomologist, Bureau of Entomology and Plant Quarantine, in recognition of his studies of insect biology and methods of insect control, in particular his researches on fumigation with methyl bromide.

Samuel L. Madorsky, research chemist, National Bureau of Standards, in recognition of his research in physical chemistry and in particular his development of methods to separate stable isotopes and his research on thermal dissociation of polymers.

Louis C. McCabe, chief, office of air and stream pollution, Bureau of Mines, in recognition of his work on the geology and utilization of coal and in particular his distinguished service in improving Army coal procurement methods and coal-mine operations after the Allied invasion of Germany.

Albert E. McPherson, mechanical engineer, National Bureau of Standards, in recognition of his contributions to engineering mechanics and in particular his researches on the behavior of aircraft structures under static and dynamic loads.

José Oiticica Filho, entomologist, Museu Nacional, Rio de Janeiro, Brazil (temporarily in Washington, D. C.), in recognition of his researches on the taxonomy and distribution of the Lepidoptera, with particular reference to the Saturniidae, Sphingidae, and related families.

Chester H. Page, electronics consultant, National Bureau of Standards, in recognition of his outstanding contributions to the theory and development of radio-proximity fuzes and their countermeasures and to the understanding of vacuum-tube oscillators.

Theron P. Sager, chemist, National Bureau of Standards, in recognition of his studies of the permeability of films of natural and synthetic polymers to gases.

A. C. Smith, curator, division of phanerogams, U. S. National Museum, in recognition of his contributions to plant taxonomy, especially to knowledge of flowering plants of tropical America, Asia, and the Pacific.

Harry H. Stage, assistant chief, division of insects affecting man and animals, Bureau of Entomology and Plant Quarantine, in recognition of his investigational work on the habits and control of insects affecting human health and for his highly successful presentation of the results of such work in a style appreciated by the general public.

Robert D. Stiehler, chief, testing and specifications section, organic and fibrous materials division, National Bureau of Standards, in recognition of his research in the field of chemistry and technology of rubber and in particular his theories of the mechanism of the vulcanization of rubber, and also for his work on the oxidation and reduction of organic compounds of biological importance.

Douglas R. Tate, physicist, National Bureau of Standards, in recognition of his contributions to engineering mechanics, and in particular his researches on hardness, force, and strain measuring equipment.

Leo A. Wall, chemist, National Bureau of Standards, in recognition of his contributions to high-polymer chemistry, and in particular for his studies of copolymerization and the structure of polymers.

Elected May 15, 1950

H. R. Bird, in charge, poultry investigations, Bureau of Animal Industry, in recognition of his research in the field of poultry nutrition, especially as regards the role of vitamin B_{12} on hatchability of eggs and on viability and feathering of chicks.

Raymond M. Gilmore, biologist in charge, whale investigations, Fish and Wildlife Service, in recognition of his valuable contributions to the ethnozoology of South America, to the systematics of Arctic mammals, and to the biology and habits of whales and their relatives.

John L. Hague, chemist, National Bureau of Standards, in recognition of his contributions to analytical chemistry, in particular the application of instrumental and spectrophotometric methods to metallurgical analysis.

Gerson Kegeles, physical chemist, National Cancer Institute, in recognition of his contributions to physical chemistry and in particular for his development of an optical method for the study of diffusion and sedimentation.

H. A. Thomas, physicist, National Bureau of Standards, in recognition of his contributions to atomic physics, in particular his work on the proton moment, value of e/m, and other atomic constants.

Charles Weir, physicist, National Bureau of Standards, in recognition of his contributions to the physics of leather and rubber and in particular his studies of the kinetics of the shrinkage of collagen.

Alfred H. Yeomans, technologist, Bureau of Entomology and Plant Quarantine, in recognition of his investigations on the behavior of small particles in wind tunnels and of the techniques for applying insecticides, especially those studies related to the atomizing of liquids.

NONRESIDENT

Elected December 12, 1949

Perry Byerly, professor of seismology, University of California, Berkeley, Calif., in recognition of his contributions to theoretical and practical seismology, with special reference to the study of northern California earthquakes.

B. Gutenberg, director, seismological laboratory, California Institute of Technology, Pasadena, Calif., in recognition of his contributions to theoretical seismology.

H. N. Hansen, associate professor of plant pathology, University of California, Berkeley, Calif., in recognition of his work in plant pathology and mycology, especially for his notable contribution to the development of the concept of the "Dual Phenomenon" in Hyphomycetes.

William C. Snyder, associate professor of plant pathology, University of California, Berkeley, Calif., in recognition of his outstanding contributions toward an explanation of the mechanism of variation in imperfect fungi, particularly with respect to heterocaryosis and the "Dual Phenomenon" in Fusarium.

Elected March 20, 1950

Carroll F. Merriam, hydroelectric engineer, Pennsylvania Water & Power Co., Baltimore, Md., in recognition of his intensive studies and engineering applications of hydroelectricity, hydrology, rainfall, run-off, ground water, and geodetic control surveys.

Elected May 15, 1950

Lloyd E. Rozeboom, associate professor of parasitology, Johns Hopkins University, Baltimore, Md., in recognition of his numerous and outstanding contributions to medical entomology especially those concerning the biology and classification of mosquitoes important to human health.

G. W. Wharton, associate professor of zoology, Duke University, Durham, N. C., in recognition of his contributions to the biology and classification of invertebrate animals, especially chigger mites important in the transmission of disease.

PHILOSOPHICAL SOCIETY

1319th meeting

The 1319th meeting was held in the auditorium of the Cosmos Club, October 23, 1949, President Johnston presiding.

Program: T. E. Allibone, Associated Electrical Industries in England: *Lightning.*—Benjamin Franklin, "the father of lightning," first drew attention to the similarity of the electric fluid from a friction machine with that drawn from the thundercloud.

Photography with high-speed rotating lenses has shown that a flash is generally composed of three or more separate strokes occurring within a second of time; that the first stroke is formed by a pilot streamer steadily progressing to the earth with a speed of over 10^7 cm/sec; and that this is reinforced every 50 microseconds by a "stepped leader" shot from the cloud until the pilot streamer reaches the earth. Then the main stroke flows at 10^9 cm/sec, up from ground to cloud, discharging with currents averaging 20,000 amperes lasting for 25 microseconds. The charge is deposited from the cloud down the network and tracery of the leader stroke.

If a tall building, such as the Empire State Building in New York, is below the thunder clouds, the leader-stroke process may rise from ground to cloud. If buildings of less height are struck it is likely that an upward-directed leader will rise to meet the downward-advancing leader stroke, but there are no photographs of this extent. A few records at ground level shows evidence of upward leaders rising from ground for some meters.

Measurements of field charges at great distances, from or near to thunderclouds, support the general picture given by photography. Pilot-streamer and stepped-leader stroke processes have been recorded in laboratory sparks, and interesting differences between positive and negative sparks have been recorded, but there is no photograph of a positive lightning flash.

Oscillographic and other records on transmission lines have given information regarding the amplitudes and direction of currents in strokes. The main stroke, lasting up to 100 microseconds, can be well correlated in detail with the luminosity time characteristic of the stroke. In addition, the oscillograph shows the existence of a "confirming stroke" a low current discharge lasting milliseconds at the order of 100 amperes often over the whole period between successive strokes in a flash.

Field-charge measurements disclose that the upper positively charged regions of a cloud are discharging at low rate after the manner forecast by C. T. R. Wilson, thus supplying from all the storms in progress over the globe, the few 1,000 amperes necessary to maintain the heaviside layer. Bomber flights over clouds have confirmed such currents. (*Author's abstract.*)

1320th meeting

The 1320th meeting was held in the auditorium of the Cosmos Club, November 5, 1949, President Johnston presiding.

Program: John S. Hall, U. S. Naval Observatory: *The matter of interstellar space.*—A brief survey was presented of studies made to determine the nature of interstellar material during the past 45 years. Since Hartmann's classic discovery of the presence of interstellar calcium in 1904, many investigations have been carried on both here and abroad.

Several gaseous clouds, hundreds of light years in extent, have been outlined from a study of their absorption lines in the spectra of stars. Emission spectra of gases in the vicinity of very hot stars in many parts of the sky have been observed. Hydrogen is by far the most prevalent element in interstellar space; oxygen, calcium, sodium, potassium, titanium, and neutral iron are also present. The molecules CN, CH, and $CH+$ have been identified.

The distribution of solid particles appears to be very erratic near the plane of the galaxy; these particles are comparable in size to a wavelength of light. Much larger particles—meteors, micrometeorites, and meteorites—are being constantly encountered by the earth.

Theoretical discussions have indicated that some of the smaller particles may be ferromagnetic. Fermi has recently postulated the existence of magnetic fields as contributory to the origin of cosmic rays. Polarization of starlight recently observed at the Yerkes and Naval Observatories may be due to selective scattering by ferromagnetic particles whose long dimension is parallel to magnetic lines of force in galactic space.

After allowance has been made for the obscuration caused by interstellar material, astronomers conclude that the size of our galaxy is only about twice that of its nearest counterpart—the Andromeda nebula. The Solar System is about 30,000 light years from the galactic center. (*Author's abstract.*)

1321ST MEETING

The 1321st meeting was held in the auditorium of the Cosmos Club, November 19, 1949, President JOHNSTON presiding.

Program: F. D. HENDRICKS, Food and Drug Administration: *Antibiotics.*—The discussion was limited to the five antibiotics certified by the United States Food and Drug Administration. The following topics were discussed with regard to each antibiotic: (1) Historical aspects; (2) important physical and chemical aspects; (3) the use of each drug in the diseased states; (4) general discussion.

The most important antibiotic is pencillin. It was discovered "accidentally" by Fleming in 1927. Its possibilities were not realized for 10 years. World War II and the requirements of United States troops made it a No. 1 priority study. The development of a better strain of the organism producing penicillin and the change in the method of culture from surface to the deep tank have made it possible to produce penicillin at enormous yields and at low prices.

General characteristics of streptomycin were discussed. Its chief use, i.e., in the treatment of exudative tuberculosis, was pointed out.

The discovery of bacitracin was accompanied by promise of its use in human infections. Its toxicity to the mammalian kidney when given by injection has limited its use to topical and oral administration. It produces excellent results in this manner with a minimum of sensitivity developing.

Aureomycin was called the "wonder drug of 1948" by some investigators. It is produced by an ultramold. Its activity against all bacteria has a wide range. Its potentialities are not yet realized.

Chloramphenicol was also the product of an ultramold, and its history and uses more or less parallel those of aureomycin, although less is known about it. It is less toxic than aureomycin. Its use against typhoid has produced encouraging results. (*Author's abstract.*)

1322D MEETING

The 1322d meeting, the 79th annual meeting, was held in the auditorium of the Cosmos Club, December 3, 1949, President JOHNSTON presiding.

The report of the Treasurer, LAWRENCE A. WOOD, showed an income for 1949 from dues and investments amounting to $1,818.17. Expenditures for the year amounted to $1,526.79, leaving a surplus of $291.38. The current expenses increased from $2.83 per member in 1948 to $2.86 per member in 1949. The total estimated assets of the Society as of December 1, 1949, were $17,215.85 as compared with $15,655.67 on December 1, 1948. The Auditing Committee reported that the Treasurer's records and report were correct.

The joint report of the Secretaries was read by the Recording Secretary, Mr. MAHAN. This report showed a net gain of 9 new members during the year and an active membership of 531 on December 1, 1949.

The report of the Committee on Elections showed that the following officers had been elected for the coming year:

President: F. C. KRACEK.
Vice Presidents: E. U. CONDON, A. G. McNISH.
Recording Secretary: A. E. RUARK.
Treasurer: L. A. WOOD.
Members at Large of the General Committee: S. E. Forbush, B. L. Wilson.

In the general discussion from the floor, a motion was made to change the meeting night from Saturday to Friday. This motion was defeated. A motion suggesting that the membership be sent a preferential ballot carried.

Program: J. A. HIPPLE, National Bureau of Standards: *Precise measurement of atomic masses.*—The history and development of mass spectrograph methods for measuring atomic masses were traced from Aston's first instrument in 1919 up to the present. Those in addition to Aston making major contributions to this field of mass spectrography were, according to the speaker, Dempster, Bainbridge, Jordan, Mattauch, and Nier. Some results of mass measurements and the packing effect found in various atoms and the accuracy of mass measurements with these instruments were discussed.

One of the newly elected vice presidents, Mr. McNISH, was asked to serve as the representative for the newly elected President, Mr. KRACEK, who was ill. Mr. McNISH was escorted to the rostrum by Past Presidents SILSBEE and STIMSON and was given the gavel by President JOHNSTON. Mr. McNISH expressed his appreciation for the honor bestowed upon him as the personal representative for Mr. KRACEK and after announcing that the next meeting would be addressed by DEAN BURK, of the National Institutes of Health, adjourned the meeting for the social hour at 10:13 P.M. (*Secretary's abstract.*)

1323D MEETING

The 1323d meeting was held in the auditorium of the Cosmos Club, December 17, 1949, President KRACEK presiding.

Program: DEAN BURK, National Institutes of Health: *Thermodynamic aspects of photosynthesis.*—The efficiency of the energy transformation "chemical energy gained per light energy absorbed" in photosynthesis by *Chlorella pyrenoidosa* has been found to attain a maximum of at least 65–85 percent (3–4 quanta of red light per molecule of O_2 produced or CO_2 consumed). These high efficiencies were measured not only with low light intensities below the compensation point and for short periods of time (minutes) but also with light intensities five to twenty times the respiration-compensation intensity in experiments lasting many hours. At such intensities red light (630–660 mu) was shown not to affect respiration *per se*, either autocatalytically or stoichiometrically, by photoreduction of respiratory intermediates, so that thermodynamic allowance for respiration during photosynthesis could be made unambiguously, or eliminated altogether, in calculating the photosynthetic yield. In carbonate buffer (pH 9) the efficiency was only one-half to one-third as great as in culture medium at pH 5, and intermediate efficiencies were obtained in bicarbonate medium at pH 7. The assimilatory quotient (CO_2 consumed/O_2 produced) averaged-1.05 + 0.25, without evidence of notable CO_2 outburst immediately upon illumination or inburst upon darkening. The nearly perfect conversion of light energy into chemical energy in photosynthesis assures the potential importance of this process as a future source of energy. (*Author's abstract.*)

1324TH MEETING

The 1324th meeting was held in the auditorium of the Cosmos Club, January 14, 1950, President KRACEK presiding.

The retiring president, FRANCIS E. JOHNSTON, George Washington University, delivered his presidential address on the subject *The theory of group representations.* After a few brief remarks about the history and development of groups, some of the simpler fundamental operations involving the product of elements, such as their associative properties, the identity operation, and the inverse operation, were presented. Using these fundamental operations, the speaker then derived and discussed various types of groups. As examples an element and all its powers or sets of nonsingular matrices were shown to be groups. Group theory itself, according to Mr. JOHNSTON, began with a study of permutations. Examples of permutations and groups that were derived from such permutations were also presented. The latter part of the lecture was devoted primarily to matrices, matrix operations, matrix transformations, and the types of groups and representations that could be derived from such operations. Numerous examples of groups and group representations were presented in the form of slides. (*Secretary's abstract.*)

This address will later be published in complete form in this JOURNAL.

1325TH MEETING

The 1325th meeting was held in the auditorium of the Cosmos Club, February 11, 1950, President Kracek presiding.

Program: R. E. Lapp: *Modern explosives and the national security.*—The peak in the rising curve of weapon development will be reached when the hydrogen bomb is developed. Fusion-type weapons, as contrasted with uranium fission bombs, derive energy from the fusing of hydrogen atoms into helium atoms, releasing 20 Mev of energy per fusion. Conventional U^{235} fission releases 200 Mev per fission, but the explosive violence of the reaction is limited by critical size of the assembly. Fusion weapons are not restricted by any critical size and can conceivably be made to be the equivalent of 1 million tons of TNT (i.e., a 1 megaton bomb). Even larger bombs might be made, but these would not find "compatible targets" since the 1 megaton bomb is already so destructive that it would find application only against very large cities.

Mr. Lapp stressed the fact that no H-bomb has been made and that many technical difficulties lie ahead. There is even the possibility that the thermonuclear reaction may not be realizable or if realized would engender serious difficulties in transportation to the target system. Possession of the H-bomb by another country would give her an enormous advantage over this country. Not only would it have the advantage of a surprise blitz against vastly more vulnerable targets, but also it would be able to evacuate its own cities prior to our own retaliatory effort. The existence of many cities of appropriate size and attractiveness to the H-bomb should be a compelling reason for serious consideration of the dispersal of our populations.

The speaker emphasized the fact that although it was a scientific possibility for 10 to 15 million of our citizens to become casualties overnight it was a far cry from this being a political probability. He urged public discussion of the H-bomb and its effects. In this connection, Mr. Lapp felt we had already wasted five years because of a futile policy of secrecy on the A-bomb and that an immediate prospectus on the H-bomb was required to stimulate thinking on the subject. Mr. Lapp presented his own prospectus on the bomb, giving areas of expectable damage from heat, blast, and penetrating radiation. He noted that the danger of persistent or prolonged radioactivity in the case of an H-bomb was correspondingly much less than for atomic weapons. (*Author's abstract.*)

Mr. Walter Ramberg, of the National Bureau of Standards, presented an informal communication entitled *Distortion of a section* of bent wire.

1326TH MEETING

The 1326th meeting was held in the auditorium of the Cosmos Club, February 25, 1950, President Kracek presiding.

Program: J. R. Pellam, National Bureau of Standards: *Recent experiments in liquid helium II.*—The subject of liquid helium II was introduced by means of a short motion-picture film illustrating some of the more unusual properties of the substance. For example, the λ-point transition from the helium I state to the helium II state was demonstrated by showing the sudden cessation of boiling as the temperature dropped below the critical 2.19°K. Other manifestation of the peculiar thermal properties of liquid helium II were illustrated, including the so-called "fountain effect." For the fountain effect, heat was shown applied to the upper portion of a capillary immersed in liquid helium II with the resultant formation of a jet or fountain of the liquid. All these phenomena are forms of the general thermomechanical property of liquid helium II, wherein thermal and mechanical processes are inseparably related.

Perhaps the most physically significant aspect of the thermomechanical effect is the ability of the liquid to support thermal waves. These temperature waves, known as "second sound," conform to the wave equation and thus travel with a characteristic definite wave velocity. They can be set up as standing temperature waves in resonant chambers or can be pulsed as packets of heat progressing through the liquid. Microphones are not activated by second sound, and so detection must ordinarily be accomplished by means of temperature sensitive devices.

In recent experiments at the Bureau of Standards, second sound has been detected and measured mechanically for the first time. Although no net pressure fluctuation or net mass flow accompanies the waves, currently proposed theories of helium II suggest that an "internal" kinetic energy density should exist. Thus, whereas microphones are insensitive (recognizing pressure fluctuations or particle velocity), the device known as the Rayleigh Disk responds to the presence of this kinetic energy and is accordingly activated by second sound.

Other recent experiments include the measurement of second sound velocity at temperatures attainable by adiabatic demagnetization, i.e., below 1°K. The observed strong increase in wave velocity at these lowest temperatures has theoretical significance with respect to the current two-fluid hypothesis of liquid helium II. (*Author's abstract.*)

1327TH MEETING

The 1327th meeting was held in the auditorim of the Cosmos Club, March 11, 1950, President KRACEK presiding.

Program: W. F. G. SWANN, Bartol Research Foundation: *Trends of thinking in modern physics.*—The lecture comprised the philosophic discussion of the nature of physical theories as they have developed from the pre-Galilean period to the present day.

A theory is a means of deducing one set of circumstances from another. A good theory is one in which, by saying few things, we can deduce many consequences. A poor theory requires the giving of many things as a start and in its worst form is nothing but a compilation of information. The idea of a model is extraneous to the purpose of a theory, but it is essential to any theory that one shall be able to realize a one-to-one correspondence between the elements of the theory and something in the mind.

Sophistication in physical theories is good, but semisophistication can breed illusions of valueless content.

The lecture was illustrated by examples from celestial mechanics, atomic structure, the quantum theory, and the theory of relativity, and a brief discussion of the significance of a unified field theory was given. (*Author's abstract.*)

1328TH MEETING

The 1328th meeting was held in the auditorim of the Cosmos Club, March 25, 1950, President KRACEK presiding.

Program: BRUCE H. BILLINGS, Baird Associates: *Right and left in physics.*—What was meant by right and left in physics was first demonstrated by an image inversion on the screen obtained by reversing a colored slide in the projector. The primary right and left which concerned the speaker, however, was that of optical activity in crystals, liquids, and various proteins. These materials were referred to as circularly anisotropic and have the property of rotating the plane of polarization of incident plane polarized light. The birefringent properties of crystals of ammonium dihydrogen phosphate and quartz were illustrated by projecting the interference rings on the screen which appear when these crystals are placed between crossed polaroids in a diverging beam of mercury light. Patterns were shown for right- and left-handed crystals and for a combination of the two. The most outstanding demonstration of the evening was that of making a uniaxial crystal of ammonium dihydrogen phosphate function as a biaxial crystal when placed between crossed polaroids in a diverging beam of mercury light. This was done by first coating surfaces of the crystal with a transparent conducting film and then applying about 10,000 volts in a direction parallel to the crystal axis. (*Secretary's abstract.*)

1329TH MEETING

The 1329th meeting was held in the auditorium of the Cosmos Club, April 8, 1950, President KRACEK presiding.

Program: J. R. ZACHARIAS, Massachusetts Institute of Technology: *Molecular beams.*—A discussion was given of the advantages of combining the mass spectrograph with a molecular beam apparatus. A new double-focusing mass spectrograph designed for the purpose of obtaining high abundance resolution was described. It was indicated that it is possible to work with concentrations of rare isotopes of 1 part in 10^7 in quantities of less than a millimicromole of material. (*Author's abstract.*)

Mr. A. G. MCNISH, of the National Bureau of Standards, presented an informal communication on *The relation between critical penetration frequencies for the F layer and the phases of the moon as observed above Peru and Trinidad.*

1330TH MEETING

The 1330th meeting was held in the auditorium of the Cosmos Club, April 22, 1950, President KRACEK presiding.

Program: J. HILLIER, RCA Laboratories: *Present status of electron microscopy.*—Some of the newer developments of the instrumentation of electron microscopy were described, including in particular an auxiliary intermediate lens for increasing the range of magnification of the conventional electron microscope and a new small permanent magnet instrument, which is particularly useful for research problems that do not require the ultimate in resolving power. Some of the more recent refinements in the electron optics of the larger electron microscopes were also described and a number of micrographs demonstrating resolutions in the range 10A-20A were shown.

Newer specimen techniques for use in the study of microorganisms and viruses were described. In general, these involved an attempt to examine the material with a minimum of manipulation. In the technique which most nearly satisfies all of the requirements, the organisms are grown under semiarid conditions directly on the membrane which subsequently supports the specimen in the instrument. The only treatments to which such specimens are subjected is a final desiccation in air.

Recent developments in the sectioning of tissues involve the use of a reservior on the microtome knife to permit obtaining serial sections. Reduction of static friction in the microtome, the elimination of vibration and the compensation of thermal changes permit sections of known thickness to be cut with a high degree of accuracy. By means of serial sections, it was shown that the only subsequent treatment to which the sections could be subjected was no treatment at all.

In conclusion it was pointed out that the electron microscope provides single instantaneous photographs of a given specimen and that electron microscope images alone do not enable a worker to follow the detailed morphological changes which can occur in a complex biological system. To do this it is necessary to devise suitable independent experiments. (*Author's abstract.*)

1331st MEETING

The 1331st meeting was held in the auditorium of the Cosmos Club, May 6, 1950, President Kracek presiding.

Program: A. Parker, Fuel Research Center, London, England: *Fuel research in Great Britain.*—It was pointed out that England's primary fuel is coal and that oil and gas are virtually nonexistent. Prior to World War I not much research was done on fuels. However, at the close of this war it was realized that the coal supply might eventually become low, and steps were taken to conserve it. A Fuel Research Center was established in 1919, and since that time fuel research has grown until now there are separate organizations for coal, coke, gas, and electricity. Each of these activities has also been brought directly under government control so as to further conserve the usage of fuels.

The Fuel Research Center, at which the speaker is the director, works on a wide variety of fuel problems. The physical and chemical properties of coal have been surveyed. Coal has also been utilized in the making of gas and oil. More economic methods of burning coal in which the coal is circulated and burned under pressure have been investigated. Boilers have been developed that burn coal without smoke. These have been particularly useful on ships in the British fleet. The subject of domestic heating has also been studied with the help of a calorimetric house having radiometric recording devices in each of the rooms. (*Secretary's abstract.*)

President Kracek announced that the General Committee as a result of the vote of the membership had decided that meetings of the Society starting in October would be held on alternate Fridays rather than on alternate Saturdays.

1332d MEETING

The 1332d meeting of the Society was the occasion of the nineteenth Joseph Henry Lecture and was held in the auditorium of the Cosmos Club, May 13, 1950, President Kracek presiding

Program: William Shockley, Bell Telephone Laboratories: *New phenomena of electronic conduction in semiconductors.*—Attention was drawn to the methods used for explaining conduction in semiconductors and to the older and newer experiments in this field. The older experiments described were conductivity measurements, Hall Effect measurements and conductivity measurements using radioactive antimony. By a combination of these three experiments, it is possible to determine the sign of the conducting particle and thus to establish whether the conduction was by electrons or holes. The newer experiments mentioned were the Haynes and Suhl experiments and the work on transistors. These newer experiments were of particular significance, since it is now possible by injection methods to introduce either holes or electrons into known semiconductors and determine their mobilities and paths in electric and magnetic fields by the use of probes. In the work on transistors it was found possible to obtain a rectifying action by placing an n-type semiconductor in contact with a p-type.

Upon contact, there is a potential developed which urges the electrons in the direction of the p-type semiconductor thus creating a resulting rectifying action. (*Secretary's abstract.*)

This lecture will be published in detail later in this JOURNAL.

1333D MEETING

The 1333d meeting was held in the auditorium of the Cosmos Club, May 19, 1950, President KRACEK presiding.

Program: D. H. MENZEL, Harvard Observatory: *The sun and the universe.*—Records from a unique-type solar telescope are opening up new studies of the effect of the sun on the earth. In the early 1930's M. Bernard Lyot, a French astronomer, designed and built an instrument that he called a coronagraph and that has made it possible to photograph and study the solar prominences as well as other coronal effects.

The field of radiocommunication has contributed further to the study of solar effects in its effort to determine and eliminate the effects of certain atmospheric disturbances which hamper communication. It has been determined that the ionosphere, a series of "layers" of ionized gas lying 70 to 100 miles or more outside the earth's surface, have much to do with these disturbances, that the ionization is caused directly by ultraviolet radiation from the sun.

It is difficult to ascribe terrestrial disturbances to specific solar phenomena. Mr. Dellinger, formerly chief of the Central Radio Propagation Laboratory of the National Bureau of Standards, has found, however, a direct relationship between solar flares and radio fadeouts. Motion-picture records of solar disturbances and study of the changes of such solar features as sunspots, prominences, flares, and the coronal spectra are being used to clarify the relationship between sun and earth.

The "spicules," expanding jets of gas at the solar poles, are under investigation as the source of the coronal material and of matter reaching the ionosphere. Studies of vagaries in weather and of solar and galactic radio noise augment the search for a predictable relationship between variations of solar and terrestrial activity. (*Author's abstract.*)

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MATHEMATICS.—*On the balance between deformation and rotation in the motion of a continuous medium.*[1] C. TRUESDELL, Naval Research Laboratory.

A fundamental theorem[2] of Cauchy and Stokes states that the most general continuous motion of a medium may be resolved locally and instantaneously into a translation, an extension along three mutually orthogonal axes, and a rigid rotation of these axes. If **v** denote the velocity vector, then a proper measure of the rate of rotation is afforded by the vorticity vector **w**:

$$w_i \equiv -e_{ijk}v_{j,k}\,, \tag{1}$$

while a proper measure of the extension is afforded by the rate of deformation tensor **d**:

$$d_{ij} \equiv \tfrac{1}{2}(v_{i,j} + v_{j,i}). \tag{2}$$

The first purpose of the present paper is to show that in a large class of motions these two quantities are not altogether independent but must submit their relative contributions to the control of a relation connecting the space averages of certain associated scalar magnitudes. These scalars are the vorticity magnitude:

$$w \equiv \sqrt{w_i w_i}\,, \tag{3}$$

and the second invariant of **d**:

$$II_d \equiv \tfrac{1}{2}e_{ijk}e_{ilm}d_{jl}d_{km}\,. \tag{4}$$

Our analysis is purely kinematical, and thus is valid for continuous motions of all types of media.

Writing $\theta \equiv \operatorname{div} \mathbf{v} = v_{i,i}$, we have

$$\begin{aligned}(v_i v_{j,i} - \theta v_j)_{,j} &= -\theta^2 + v_{i,j}v_{j,i}\,,\\ &= -\theta^2 + (d_{ij} + \tfrac{1}{2}[v_{i,j} - v_{j,i}])\\ &\qquad (d_{ji} + \tfrac{1}{2}[v_{j,i} - v_{i,j}]), \qquad (5)\\ &= -\theta^2 + d_{ij}d_{ij} - \tfrac{1}{2}w^2.\end{aligned}$$

Now in terms of the principal rates of extension d_i we have

$$\begin{aligned}-\theta^2 + d_{ij}d_{ij} &= -(d_1 + d_2 + d_3)^2 + d_1^2 + d_2^2 + d_3^2,\\ &= -2(d_1d_2 + d_2d_3 + d_3d_1), \qquad (6)\\ &= -2II_d,\end{aligned}$$

and hence (5) becomes

$$(v_iv_{j,i} - \theta v_j)_{,j} = -2II_d - \tfrac{1}{2}w^2. \tag{7}$$

If we integrate this identity over a volume and then apply the divergence theorem to the result, we obtain

$$\int_V (4II_d + w^2)\,dV = 2\oint_S dS_j[v_j\theta - v_iv_{j,i}]. \tag{8}$$

Since the acceleration **a** is given by

$$a_j = \frac{\partial v_j}{\partial t} + v_iv_{j,i}\,, \tag{9}$$

we may put (8) into the alternative form

$$\int_V (4II_d + w^2)\,dV = 2\oint_S dS_j\left[v_j\theta - a_j + \frac{\partial v_j}{\partial t}\right]. \tag{10}$$

By formulating conditions under which the surface integral on the right vanishes, we obtain the following THEOREM OF AVERAGE BALANCE BETWEEN VORTICITY AND DEFORMATION: *If all finite boundaries of a continuously differentiable motion be stationary, and if upon them the material adhere without*

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[1] Received August 22, 1950.

[2] E.g., §30 of LAMB, *Hydrodynamics*, ed. 6. Cambridge, 1932.

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slipping ($\mathbf{v} = 0$), *while in any portion of the material extending to* ∞ *the condition*

$$r^2 \left(a_r - \frac{\partial v_r}{\partial t} - \theta v_r \right) \rightarrow 0 \qquad (11)$$

be satisfied, then the average value of $4II_d + w^2$ *throughout the motion is zero:*

$$\int_V (4II_d + w^2)\, dV = 0. \qquad (12)$$

COROLLARY 1. *For a motion of the type described in the theorem to be rotational* ($\mathbf{w} \neq 0$) *it is necessary that there exist within it a region where*

$$II_d < 0. \qquad (13)$$

COROLLARY 2. *In an irrotational motion* ($\mathbf{w} = 0$) *satisfying the hypotheses of the theorem the average value of* II_d *is zero:*

$$\int_V II_d\, dV = 0. \qquad (14)$$

COROLLARY 3. *In an isochoric*[3] *motion of the type described in the theorem the average value of the squared vorticity must equal twice the average value of the squared intensity of deformation:*

$$\int_V w^2\, dV = 2 \int_V d_{ij} d_{ij}\, dV. \qquad (15)$$

The proofs of corollaries 1 and 2 are immediate, and corollary 3 follows from (6). We notice in passing that from corollary 3 and the fact that $d_{ij}d_{ij} > 0$ if $\mathbf{d} \neq 0$ we may obtain a proof of the well-known theorem on the impossibility of irrotational motions in a finite domain to whose boundaries the material adheres.

The theorem of average balance states that in a broad class of motions the average value of the invariant $4II_d + w^2$ is zero. We may now seek to characterize those motions in which this average balance between deformation and vorticity is satisfied by the exact balance $4II_d + w^2 = 0$ at every point. The condition $4II_d + w^2 = 0$ occurs in a recent work of Bilimovitch,[4] who investigated the possible generalization of an earlier and apparently unrelated theorem of Pompeiu.[5] Guided by the outcome of this study, we shall present a somewhat more general analysis, which will yield the theorem of Bilimovitch as a special case.

Let a closed surface S be given by the parametric vectorial equation $\mathbf{r} = \mathbf{r}(l, m)$. Then from the divergence theorem it follows that the volume V_S enclosed by S is given by

$$3V_S = \oint_S d\mathbf{S} \cdot \mathbf{r} = \oint_S \frac{\partial \mathbf{r}}{\partial l} \times \frac{\partial \mathbf{r}}{\partial m} \cdot \mathbf{r}\, dl\, dm, \quad (16)$$

where a plus or minus sign is attached quite arbitrarily to V_S as a consequence of the manner of parametrization. Now consider the velocity vector $\mathbf{v}(\mathbf{r}, t) = \mathbf{v}(\mathbf{r}(l, m), t) = \mathbf{v}(l, m, t)$ at the points $\mathbf{r}$ upon S. The termini of these vectors sweep out a surface, whose enclosed volume V_V is obtained by replacing $\mathbf{r}$ by $\mathbf{r} + \mathbf{v}$ in (16), viz.

$$3V_V = \oint_S \frac{\partial(\mathbf{r} + \mathbf{v})}{\partial l} \times \frac{\partial(\mathbf{r} + \mathbf{v})}{\partial m} \cdot (\mathbf{r} + \mathbf{v})\, dl\, dm. \quad (17)$$

We shall call V_V the *velocital volume* of the surface. If the origins of these same velocity vectors be put at the origin of co-ordinates, their termini sweep out a third surface, whose enclosed volume V_H is given by

$$3V_H = \oint_S \frac{\partial \mathbf{v}}{\partial l} \times \frac{\partial \mathbf{v}}{\partial m} \cdot \mathbf{v}\, dl\, dm. \quad (18)$$

We shall call V_H the *hydrographic volume* of the surface. The parameters l and m are selected once for all in the parametrization of S, so that the parametrization in (17) and (18) is induced by this initial choice;

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[3] An isochoric motion is one in which the volume of the portion of space occupied by each material volume is constant in time: $\theta = 0$.

[4] BILIMOVITCH, A., *Aires et volumes vélocidiques et hodographiques dans un mouvement du fluide*, Acad. Serbe Sci. Publ. Inst. Math. **2**: 37–52. 1948. In my review (Math. Rev. **10**: 517. 1949) of this paper the factor 4 is erroneously omitted from the condition.

[5] POMPEIU, D. *Sur la condition des vitesses dans un fluide incompressible*, Bull. Math. Phys. École Poly. Bucarest **1**: 42–43. 1929. Other generalizations of Pompeiu's result are obtained by C. Jacob, *Sur une interprétation de l'équation de continuité hydrodynamique*, Bull. Math. Soc. Roumaine Sci. **46**: 81–90. 1944.

in particular, while the sign of V_S is arbitrary, the signs of V_V and of V_H are induced by it. By multiplying out in (17) we obtain

$$\begin{aligned} 3V_V = \oint_S \Big\{ & \frac{\partial \mathbf{r}}{\partial l} \times \frac{\partial \mathbf{r}}{\partial m} \cdot \mathbf{r} + \frac{\partial \mathbf{v}}{\partial l} \times \frac{\partial \mathbf{v}}{\partial m} \cdot \mathbf{v} \\ & + \frac{\partial \mathbf{r}}{\partial l} \times \frac{\partial \mathbf{r}}{\partial m} \cdot \mathbf{v} + \frac{\partial \mathbf{v}}{\partial l} \times \frac{\partial \mathbf{v}}{\partial m} \cdot \mathbf{r} \\ & + \left[\frac{\partial \mathbf{r}}{\partial l} \times \frac{\partial \mathbf{r}}{\partial m} + \frac{\partial \mathbf{r}}{\partial l} \times \frac{\partial \mathbf{v}}{\partial m} \right] \\ & \cdot (\mathbf{r} + \mathbf{v}) \Big\} \, dl \, dm, \qquad (19) \\ = 3V_S + 3V_H & + \oint_S d\mathbf{S} \cdot \mathbf{v} \\ & + \oint_S \frac{\partial \mathbf{v}}{\partial l} \times \frac{\partial \mathbf{v}}{\partial m} \cdot \mathbf{r} \, dl \, dm \\ & + \oint_S \left[\frac{\partial \mathbf{v}}{\partial l} \times \frac{\partial \mathbf{r}}{\partial m} + \frac{\partial \mathbf{r}}{\partial l} \times \frac{\partial \mathbf{v}}{\partial m} \right] \\ & \cdot (\mathbf{r} + \mathbf{v}) \, dl \, dm. \end{aligned}$$

Now the second integral on the right in this identity may be obtained from the first by interchanging the roles of $\mathbf{r}$ and $\mathbf{v}$. Thus by the divergence theorem we have

$$\oint_S \frac{\partial \mathbf{v}}{\partial l} \times \frac{\partial \mathbf{v}}{\partial m} \cdot \mathbf{r} \, dl \, dm = \int_V \operatorname{div}' \mathbf{r} \, dV', \qquad (20)$$

where primes indicate that the components of $\mathbf{v}$ are to be taken as independent variables. The ordinary formula for the element of volume yields

$$dV' = J \, dV, \qquad (21)$$

where J is the Jacobian $\partial(v_x, v_y, v_z)/\partial(x, y, z)$. Now let us regard $\mathbf{r}$ as a function of $\mathbf{v}$, at the same time referring both these quantities to a rectangular Cartesian system and reverting to the notation of Cartesian tensors. Then if

$$x_{i,j} \equiv \frac{\partial x_i}{\partial v_j}, \qquad (22)$$

we have

$$x_{i,j} v_{j,k} = \delta_{ik}, \qquad (23)$$

and hence

$$x_{i,j} = \frac{e_{ikl} e_{jmn} v_{k,m} v_{l,n}}{2J}, \qquad (24)$$

so that

$$\begin{aligned} J \operatorname{div}' \mathbf{r} = J x_{i,i} &= \tfrac{1}{2} e_{ikl} e_{imn} v_{k,m} v_{l,n}, \\ &= \tfrac{1}{2} e_{ikl} e_{imn} (d_{km} + \tfrac{1}{2}[v_{k,m} - v_{m,k}]) \\ & \quad (d_{ln} + \tfrac{1}{2}[v_{l,n} - v_{n,l}]), \\ &= \tfrac{1}{2} e_{ikl} e_{imn} d_{km} d_{ln} \qquad (25) \\ & \quad + \tfrac{1}{8} e_{ikl} e_{imn} (v_{k,m} - v_{m,k})(v_{l,n} - v_{n,l}) \\ &= II_d + \tfrac{1}{4} w^2. \end{aligned}$$

Hence (20) becomes

$$\oint_S \frac{\partial \mathbf{v}}{\partial l} \times \frac{\partial \mathbf{v}}{\partial m} \cdot \mathbf{r} \, dl \, dm = \int_V [II_d + \tfrac{1}{4} w^2] \, dV. \qquad (26)$$

To evaluate the last integral in (19) it is convenient to regard the volume V as a material volume, and the parameters l and m as material also, so that l, m, and t are independent. Then if the symbol D/Dt denote the material derivative, we have

$$\begin{aligned} \oint_S & \left[\frac{\partial \mathbf{v}}{\partial l} \times \frac{\partial \mathbf{r}}{\partial m} + \frac{\partial \mathbf{r}}{\partial l} \times \frac{\partial \mathbf{v}}{\partial m} \right] \\ & \cdot (\mathbf{r} + \mathbf{v}) \, dl \, dm = \oint_S \frac{D \, d\mathbf{S}}{Dt} \cdot (\mathbf{r} + \mathbf{v}), \\ & = \frac{D}{Dt} \oint_S d\mathbf{S} \cdot \mathbf{r} - \oint_S d\mathbf{S} \cdot \mathbf{v} \qquad (27) \\ & \qquad + \frac{D}{Dt} \int_S d\mathbf{S} \cdot \mathbf{v} - \oint_S d\mathbf{S} \cdot \mathbf{a}. \end{aligned}$$

But since

$$\begin{aligned} \frac{D}{Dt} \oint_S d\mathbf{S} \cdot \mathbf{r} &= 3 \frac{D}{Dt} \int_V dV = 3 \oint_S d\mathbf{S} \cdot \mathbf{v}, \\ \oint_S d\mathbf{S} \cdot \mathbf{v} &= \int_V \theta \, dV, \end{aligned} \qquad (28)$$

it follows that

$$\begin{aligned} \frac{D}{Dt} \int_V d\mathbf{S} \cdot \mathbf{r} - \oint_S d\mathbf{S} \cdot \mathbf{v} + \frac{D}{Dt} \int_S d\mathbf{S} \cdot \mathbf{v} \\ = 2 \oint_S d\mathbf{S} \cdot \mathbf{v} + \int_V \left[\frac{D\theta}{Dt} + \theta^2 \right] dV, \end{aligned} \qquad (29)$$

and hence (27) becomes

$$\oint_S \left[\frac{\partial \mathbf{v}}{\partial l} \times \frac{\partial \mathbf{r}}{\partial m} + \frac{\partial \mathbf{r}}{\partial l} \times \frac{\partial \mathbf{v}}{\partial m}\right] \cdot (\mathbf{r} + \mathbf{v})\, dl\, dm = 2 \oint_S d\mathbf{S}\cdot\mathbf{v} + \int_V \left[\frac{D\theta}{Dt} + \theta^2 - \operatorname{div}\mathbf{a}\right] dV. \tag{30}$$

Now from (9), (5), and (6) we have

$$\begin{aligned} \operatorname{div}\mathbf{a} = a_{j,j} &= \frac{\partial\theta}{\partial t} + (v_i v_{j,i})_{,j}, \\ &= \frac{\partial\theta}{\partial t} + v_i\theta_{,i} + v_{i,j}v_{j,i}, \\ &= \frac{D\theta}{Dt} + \theta^2 - 2II_d - \tfrac{1}{2}w^2, \end{aligned} \tag{31}$$

and hence (30) becomes

$$\oint_S \left[\frac{\partial \mathbf{v}}{\partial l} \times \frac{\partial \mathbf{r}}{\partial m} + \frac{\partial \mathbf{r}}{\partial l} \times \frac{\partial \mathbf{v}}{\partial m}\right] \cdot (\mathbf{r} + \mathbf{v})\, dl\, dm = 2 \oint_S d\mathbf{S}\cdot\mathbf{v} + \int_V (2II_d + \tfrac{1}{2}w^2)\, dV. \tag{32}$$

By putting (26) and (32) into (19), we finally obtain the identity

$$V_V = V_S + V_H + \oint_S d\mathbf{S}\cdot\mathbf{v} + \frac{1}{4}\int_V (4II_d + w^2)\, dV. \tag{33}$$

Now all the foregoing analysis possesses the rather unusual quality of lacking dimensional homogeneity. We have dim $V_S = \mathbf{L}^3$, dim $V_H = \mathbf{L}^3\mathbf{T}^{-3}$, dim $\oint d\mathbf{S}\cdot\mathbf{v} = \mathbf{L}^3\mathbf{T}^{-1}$, dim $\int (4II_d + w^2)\, dV = \mathbf{L}^3\mathbf{T}^{-2}$, while V_V is not endowed with any physical dimension whatever. This deficiency in no way invalidates the result or lessens either its physical applicability or its invariance. The equality we have proved concerns *numerical magnitudes* of quantities possessing physical interpretations. The velocital volume is constructed by forming $\mathbf{r} + \mathbf{v}$, a vector having merely numerical significance and not endowed with dimensional invariance. A change of the units of length and time effects similarity transformations upon S and upon the bounding surface of V_H, while entirely changing the geometrical shape of the surface bounding V_V. Our result (33) then possesses the following property of invariance: *Whatever the choice of units, the sum of the four* numerical magnitudes *on the right is always numerically equal to the volume* V_V. Thus the dimensional inhomogeneity is indeed an advantage: it has enabled us to deduce a one-parameter family of relations (no added generality is obtained by varying both the units **M** and **T**) at a single blow.

We shall now exploit this advantage. Since the two integrals on the right in (33) are of different dimensions, for a particular choice of units the two numerical magnitudes may have a cancelling effect upon one another. In order, however, for the relation

$$V_V = V_S + V_H \tag{34}$$

to hold *irrespective of the choice of units* it is necessary and sufficient that the two integrals vanish *separately:*

$$\oint_S d\mathbf{S}\cdot\mathbf{v} = 0, \qquad \int_V (4II_d + w^2)\, dV = 0. \tag{35}$$

Hence we obtain the GENERALIZED BILIMOVITCH THEOREM[6]: *In order that the velocital volume of an arbitrary region equal the sum of its volume and its hodographic volume, for any choice of units of length and time, it is necessary and sufficient that the motion be isochoric and satisfy the further requirement*

$$4II_d + w^2 = 0. \tag{36}$$

The slightly different result which we desire here follows also from (33). We may call it the LOCAL BALANCE THEOREM: *In order that*

$$4II_d + w^2 = 0 \tag{37}$$

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[6] In the work of Bilimovitch it is assumed at the outset that the motion is isochoric.

throughout the motion it is necessary and sufficient that the total flux of velocity out of any closed surface shall equal the excess of the velocital volume over the sum of the volume and the hodographic volume, whatever the choice of units of length and time:

$$\oint_S d\mathbf{S}\cdot\mathbf{v} = V_V - (V_S + V_H); \quad (38)$$

in particular, for an isochoric motion the condition becomes

$$V_V = V_S + V_H. \quad (39)$$

This theorem characterizes the class of motions in which the balance between deformation and rotation holds not merely on the average over the whole motion, but identically at each point.

PALEONTOLOGY.—*Bears from the Pleistocene Cave of San Josecito, Nuevo León, Mexico.*[1] Chester Stock, California Institute of Technology.

The cavern deposit of San Josecito in southern Nuevo León, Mexico, has yielded a large assemblage of Pleistocene vertebrates of which only the birds are as yet adequately known.[2] Two types of bears have been identified recently among the fossil mammals. These represent individuals closely allied to the spectacle bears (*Tremarctos*) of South America and a member of the group of black bears (*Euarctos*) of North America.

A somewhat similar composition of the post-Pliocene ursine assemblage of Mexico was described by Freudenberg,[3] except that the tremarctine type found at Tequixquiac was identified by him as belonging to *Arctotherium simum* Cope. This is the species described by Cope and others for the Pleistocene of California and is definitely a larger type than the tremarctine bear from San Josecito Cave; it is likewise generically extinct. In addition, Freudenberg[4] describes the left jaw fragment of a black bear that he refers to the living *Ursus americanus* Pallas. The location of occurrence of this specimen, according to Freudenberg, is not known.

Thus, it appears desirable to make available at this time the new record of fossil bears at the San Josecito Cave locality, particularly since the tremarctine is identified as belonging to the Recent genus, and is the first record of the latter in Mexico.

Tremarctos mexicanus, n. sp.

Type specimen.—Calif. Inst. Tech. Vert. Paleont. Coll. No. 3933, a left ramus of the mandible with P_2 to M_3 inclusive. Associated with the type is a fragment of the left maxillary with M^1 and M^2.

Paratype.—Calif. Inst. Tech. Vert. Paleont. Coll. No. 3934, a left skull fragment with P^4–M^2.

Locality and age.—San Josecito Cave, southern Nuevo León, Mexico; Calif. Inst. Tech. Vert. Paleont. Locality no. 192. Pleistocene.

Specific characters.—Larger than living species, *Tremarctos ornatus* (Cuvier), and smaller than Pleistocene bear *Arctodus floridanus* Gidley.

DISCUSSION

The most noticeable difference between the fossil and the skulls of the Recent *Tremarctos ornatus* is in character of size, the former being larger than the largest mandible available of the living spectacle bear. Expression of this difference in size between the two is shown also by the upper teeth.

In the fossil ramus, C. I. T. no. 3933, there appears to be a greater upturn of the lower rim of the mandible below the premasseteric fossa and that below the region posterior to the fossa. There is likewise a slightly greater difference in height of horizontal ramus, as measured normal to its lower border in no. 3933, than in *T. ornatus*. The crest separating the premasseteric from the masseteric fossa is curved, but its outermost part is broken away.

In the lower jaw from the Pleistocene of Nuevo León the largest mental foramen lies below and in part in front of P_3. This position is similar to that in jaws of *T. ornatus*. A foramen of slightly smaller size is situated 11.7 mm in back of the forward opening, and lies therefore below P_4. In Recent specimens a much smaller foramen lies farther back, below the posterior half of M_1.

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[1] Contribution No. 553, Division of the Geological Sciences, California Institute of Technology. Received July 2, 1950.

[2] Miller, Loye, Univ. California Publ. Zool. **47** (5): 143–168. 1943.

[3] Freudenberg, W., Geol. und. Paleont. Abh. (n. f.) **9** (3): 198–205. 1910.

[4] *Op. cit.*: 204–205. 1910.

A longer diastema separates P_2 from P_3, and also P_3 from P_4 in the fossil than in Recent specimens. Furthermore, P_4 is relatively smaller in the fossil than in the Recent. On the whole, the characters exhibited by no. 3933 and outlined in the present comparison are to be regarded as of specific rather than of generic value.

In character of size no. 3933 is intermediate between the largest examples of the Recent *Tremarctos ornatus* in the collections of the U. S. National Museum and U.S.N.M. no. 11833, the type of *Arctodus floridanus* Gidley from the Pleistocene of Melbourne, Fla. No. 3933 from San Josecito Cave likewise agrees with *A. floridanus* in the wider spacing of the premolars, for as in the latter a longer diastema separates P_2 from P_3 and P_3 from P_4 than in *T. ornatus*. These distances are greater in *A. floridanus* than in *T. mexicanus*.

Unfortunately, the jaw is broken between the base of the canine and the posterior rim of P_2 in Gidley's type, so that no reliable measurement can be taken from the anterior end of the alveolus for P_1 to the posterior side of P_4. This distance, however, in the jaw from Nuevo León appears to be only slightly shorter in relation to the length of the lower molar series than in the species from the Florida Pleistocene. In this respect, no. 3933 is also intermediate between *A. floridanus* and *T. ornatus*. The oblique crest separating the premasseteric from the masseteric fossa reaches the anterior border of the coronoid process above the level of M_3, in which respect no. 3933 approaches *A. floridanus*, but this position is approximated in some skulls of *T. ornatus*. Though the type from Melbourne unquestionably represents a form distinct from known tremarctine bears, question may be raised with regard to its generic assignment.

Gidley[5] pointed out that "*Arctodus floridanus* is distinguished from *A. pristinus* and *A. haplodon* by its smaller size and relatively narrower molars as well as by a tendency to greater numbers of the minute tubercles of the flat triturating surfaces of the molars." The lower molars of Gidley's type are narrow transversely as in *Tremarctos* and the triturating surface of M_2 and M_3 is finely

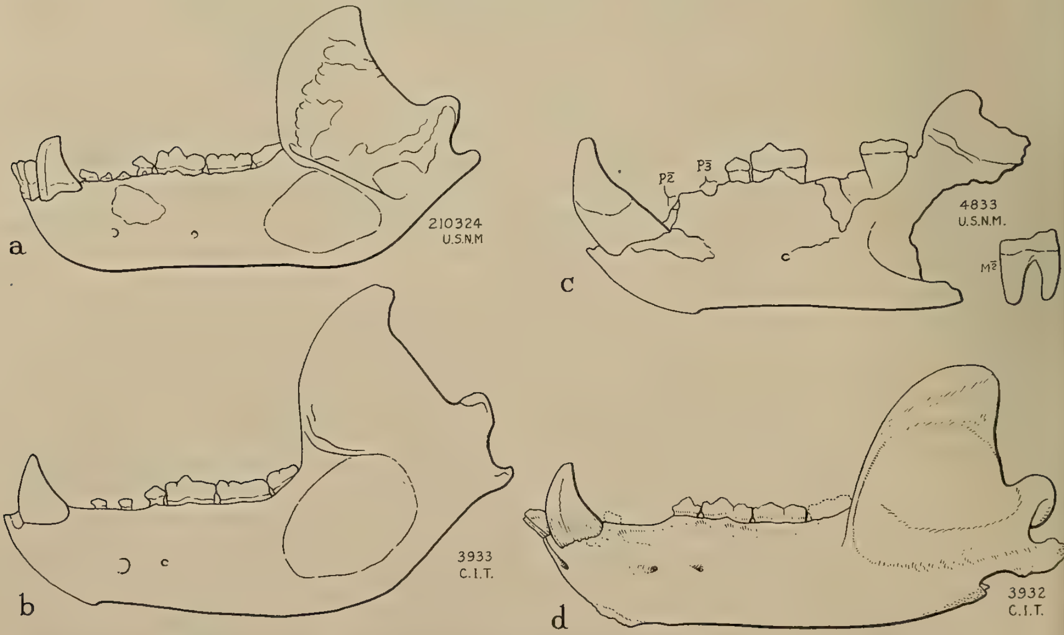

FIG. 1.—Left ramus of Recent and Pleistocene bears, lateral views, × $\frac{1}{3}$: *a*, *Tremarctos ornatus* (Cuvier), Recent, Ecuador; *b*, *T. mexicanus*, n. sp., Pleistocene, San Josecito, Nuevo León, Mexico; *c*, *Arctodus floridanus* Gidley, Pleistocene, Melbourne, Fla.; *d*, *Euarctos*, near *americanus* (Pallas), Pleistocene, San Josecito, Nuevo León, Mexico.

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[5] GIDLEY, J. W., Journ. Washington Acad. Sci. **18**: 432–433. 1928.

Table 1.—Measurements (in millimeters) of Mandibles of Tremarctos*

Measurement	CIT 3933 Pleistocene	AMNH 67732 Recent	AMNH 42493 Recent	USNM 210323	USNM 210324	USNM 271418	USNM 171011	USNM 194309	USNM 170656	USNM 170657	*Arctodus floridanus* Type USNM 11833
Length from anterior end of symphysis to midpoint of condyle		178.3	146.4	171.0	173.8	167.7	152.0	140.0	139.0	143.0	
Length from anterior end of symphysis to angle		173.0	140.4	178.3	180.6	176.3	158.4	144.7	144.8	148.0	
Length of tooth row, anterior end of base of C to posterior end of M_3	116.2	101.0	83.1	134.7	99.4 worn	*A* 96.2	88.8	82.9	84.7	86.7	134.7
Length, anterior end of alveolus from P_1 to posterior end of P_4	35.7	30.5	23.9	27.9	27.3	28.0	23.7	22.3	19.9	21.2	
Length from anterior end of M_1 to posterior end of M_3	56.3	51.8	44.4	51.7	54.1	50.2	47.5	45.2	49.6	48.3	62.4
Height of coronoid process above angle	97.1	83.7	68.3	80.8	85.5	79.0	71.7	63.7	69.2	68.2	
Depth of horizontal ramus at posterior end of M_3, taken normal to base of tooth row	45.6	37.8	31.7	40.4	40.3	37.8	30.9	30.4	30.1	29.5	
Depth of horizontal ramus at posterior end of P_2, taken normal to base of tooth row	38.5	34.9	29.5	35.4	38.1	35.1	29.7	26.3	27.6	27.5	*A*44.8
C, anteroposterior diameter at base of crown	19.6	16.8	13.6	16.5	*A*16.1	16.0	14.4	13.7	14.0	15.6	21.0
C, transverse diameter at base of crown	12.4	10.6	8.8	11.2	11.5	10.5	9.9	8.9	9.5	9.1	14.3
P_2, anteroposterior diameter	5.1	5.5	3.1	5.4		5.3	4.7	4.6	4.5	4.4	
P_2, transverse diameter	3.3	3.7	2.5	3.5		3.3	2.9	2.9	2.9	3.6	
P_3, anteroposterior diameter	4.8	5.5	3.2	4.7		5.4	4.5	4.6	4.8	5.0	
P_3, transverse diameter	3.0	4.0	2.5	3.4		3.8	2.9	3.1	3.1	3.0	
P_4, anteroposterior diameter	7.9	8.2	7.6	9.1	8.0	8.5	6.9	7.0	7.4	7.8	9.2
P_4, transverse diameter	4.6	5.9	4.5	5.6	5.6	5.6	5.0	4.7	5.3	5.4	5.6
Length of diastema between P_2 and P_3	5.4	2.0	1.4	9.1	1.9	2.0	2.0	1.3	1.2	1.2	
Length of diastema between P_3 and P_4	6.6	2.2	1.2	5.2	2.0	1.6	2.4	1.1	1.5	0.6	
M_1, anteroposterior diameter	20.0	18.9	16.4	22.3	20.0	19.2	17.5	17.3	18.7	18.0	22.4
M_1, greatest transverse diameter	9.3	9.6	7.8	11.2	10.5	9.3	8.5	8.6	8.8	9.1	11.2
M_2, anteroposterior diameter	20.8	18.4	16.8	19.2	19.9	18.0	18.3	16.9	18.3	17.2	
M_2, transverse diameter	12.1	11.7	10.0	9.8	12.1	11.5	10.8	10.0	11.4	11.0	
M_3, anteroposterior diameter	14.6	14.7	12.3	13.6	14.7	12.7	11.8	11.1	13.3	12.6	
M_3, greatest transverse diameter	11.6	10.9	9.0	11.1	12.1	11.1	10.1	8.9	10.0	10.0	

* With exception of nos. 3933 and 11833, specimens belong to living species, *Tremarctos ornatus* (Cuvier).
A, approximate.

crenulate or tuberculate as in the South American bear. The resemblance between the two extends to the location of many of the individual tubercles, which in some specimens can be identified as having the same position in both the fossil and Recent teeth. These resemblances are therefore regarded as further evidence supporting the view that the tremarctine bear from the Pleistocene of Florida is more closely related to *Tremarctos* than to *Arctodus*. Furthermore, it is the largest known species of *Tremarctos* in the former extension of range of the genus from South America into Mexico and Florida. The following additional measurements of the fossil specimens are pertinent in connection with the latter range in size:

	No. 3933 Nuevo León	*No. 4833 Florida*
M^1, anteroposterior diameter along inner side	17.3	19.3
M^1, transverse diameter across posterior third of tooth	13.8	16.1
M^2, anteroposterior diameter	27.6	31.1
M^2, transverse diameter across protoconid	14.6	16.2

In addition to the striking differences in the construction of the lower jaw in *Tremarctos* and *Euarctos*, shown by the presence in the former and absence in the latter of the premasseteric fossa, differences are likewise seen in the lower posterior portion of the ramus. The inferior border is much more curved in *Tremarctos* and sweeps directly to its posterior terminus, the angular process. In *Euarctos*, on the other hand,

Table 2.—Measurements (in millimeters) of Skulls of Tremarctos*

Measurement	CIT 3934 Pleistocene	AMNH 67732 Recent	AMNH 42493 Recent	CIT 3933 Pleistocene	USNM 210323 Recent	USNM 210324 Recent	USNM 271418 Recent	USNM 171011 Recent	USNM 194309 Recent	USNM 170656 Recent	USNM 170657 Recent
Length of tooth row, C to posterior end of M^2	110.0	89.5	75.0		88.4	88.8	*A*88.8	80.7	72.9	72.1	78.8
Length from anterior end of alveolus of P^1 to posterior end of M^2	84.1	69.7	59.0		67.9	69.1	*A*66.9	62.6	56.9	57.8	61.0
Length from anterior end of M^1 to posterior end of M^2	46.6	41.6	35.7		41.0	42.7	41.9	38.0	35.1	36.3	38.1
C, anteroposterior diameter at base of crown	19.5	*A*17.5			17.3	18.5	*A*19.3	16.0	14.1	15.2	15.3
C, transverse diameter at base of crown	12.1	11.2			12.0	12.0		10.2	8.7	9.6	8.9
P^1, anteroposterior diameter		6.9	5.3		6.1	6.9	5.6	5.8	5.6	5.2	6.1
P^1, transverse diameter		4.3	3.8		4.1	4.5	4.4	4.0	3.8	3.7	3.9
P^2, anteroposterior diameter of crown		5.1	5.0		4.8	5.7	4.1	4.8	4.6	4.5	4.4
P^2, transverse diameter of crown		3.2	3.2		3.4	3.4	3.3	2.8	3.0	2.3	2.9
P^3, anteroposterior diameter of crown		4.3	3.7		6.5	5.4	5.3	4.9	4.9	5.1	4.9
P^3, transverse diameter of crown		3.4	2.6		3.8	3.4	3.4	3.0	3.1	3.3	2.9
P^4, anteroposterior diameter along outer side	14.2	13.7	11.0		12.7	13.5	12.3	11.2	11.3	11.9	11.2
P^4, transverse diameter across protocone	11.4	9.6	7.0		9.8	9.6	9.1	8.1	8.2	8.4	8.2
M^1, anteroposterior diameter	18.2	16.7	14.8	*A*17.5	17.3	18.1	16.9	15.7	15.9	16.1	15.5
M^1, greatest transverse diameter	14.5	12.8	11.2	*A*13.6	13.6	14.7	14.0	11.6	12.5	11.9	11.7
M^2, greatest anteroposterior diameter	28.9	24.3	20.9	27.9	23.7	25.6	24.7	22.2	21.0	20.9	22.2
M^2, greatest transverse diameter	14.8	13.8	11.9	14.5	13.7	14.5	14.2	12.9	12.5	12.6	12.8
Length from anterior end of premaxillary to middle of rim of postnarial notch					115.4	117.9	108.7	104.7	91.0	89.9	98.3

* With exception of no. 3934, specimens belong to Recent species, *Tremarctos ornatus* (Cuvier).
A, approximate.

the inferior border ends well in front of the angle, and a break in the form of a notch on the lower contour of the jaw separates it from the angular process. The latter is much more prominent in *Euarctos* than in *Tremarctos* (compare Fig. 1, *a* and *d*).

In the jaw of the tremarctine bear the vertical distance between angle and condyle, as seen from the rear, is distinctly greater. In the Recent *Tremarctos* a rudimentary process may sometimes occur on the inferior border of the ramus below the true angle, but in no. 3933, as in many existing specimens, the border swings smoothly upward along the inside of the thickened ventral surface. The absence of a projection at the posterior end of the ventral border of the ramus in *Tremarctos* and its distinctness from the angle furnish additional striking differences between this genus and *Euarctos*.

Euarctos, near americanus (Pallas)

The North American black-bear group is represented in the collection by a left ramus of the mandible, Calif. Inst. Tech. Vert. Paleont. Coll. no. 3932. Comparing the specimen with jaws of the living black bear brings out the fact that the essential difference between them relates to the larger size of the molar teeth in the fossil. Other than this character, and increased size of lower canine, resemblance prevails between the available materials of the Pleistocene and Recent bears.

Table 3.—Measurements (in millimeters) of C.I.T. No. 3932

Length, anterior end of symphysis to posterior end of angle	201.0
Length, anterior end of symphysis to posterior end of middle of condyle	193.9
Height of coronoid process above angle	85.5
Length, anterior end of base of C to posterior end of M_2	100.2
Length, anterior end of P_4 to posterior end of M_2	51.0
Depth of jaw at posterior end of M_2	41.6
P_4, anteroposterior diameter	10.4
P_4, transverse diameter	5.7
M_1, anteroposterior diameter	19.3
M_1, greatest transverse diameter	9.7
M_2, anteroposterior diameter	21.7
M_2, greatest transverse diameter	13.1

Schultz,[6] in describing the species *Ursus optimus* from the Pleistocene asphalt deposits of McKittrick, Calif., called attention to the relatively larger molar dentition which distinguished this Pleistocene form. It should be indicated that the canine is likewise of larger size in the bear from McKittrick than in the modern species.

The scarcity of remains of black bears does not permit a demonstration of the extent of variation in size of the form from the Pleistocene. The jaw from San Josecito Cave is smaller than that of *U. optimus*, but like the latter it shows an increase in size of the molars, although this increase is not so great as in the Californian individual. It seems possible that the Mexican bear is a member of the group typified by the McKittrick specimen and characterized by greater range in size than is found to be true of *Euarctos americanus* today.

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[6] Schultz, J. R., Carnegie Inst. Washington Publ. 487: 178–181, pl. 11. 1938.

PALEOBOTANY.—*An Oligocene evergreen cherry from Oregon.*[1] Roland W. Brown, U. S. Geological Survey.

At Holley, Linn County, Oreg., marine fossils from rock outcrops indicate the relative position of the easternmost shoreline of the Oligocene sea. North and east of Holley, particularly in the vicinity of Sweet Home, nonmarine exposures in railroad cuts, highway cuts, and ravines, contain beautifully preserved leaves, fruits, seeds, and wood of land plants. Locally the wood is very abundant, the dominant species apparently being a kind of sycamore (*Platanus*). From a locality 12 miles east of Holley, L. W. Staples (*4*), of the University of Oregon, described some of this wood, which has the unusual feature of containing cubic pseudomorphs of quartz after halite. Staples interpreted these crystals as meaning that the lowlands where the sycamores grew were inundated by the advance of an arm of the sea, thus killing the trees. Salt solutions then permeated the dead trunks and at appropriate foci halite crystals developed, pushing the wood cells aside. Eventually, alluvial materials and volcanic ash buried the trees, ended the saline phase, and inaugurated the freshwater percolation conditions for dissolving the halite crystals and for the concentration of silica in their place.

My introduction to this geologic situation occurred during August 1949, when, in company with Dr. H. E. Vokes and Don Myers, of Johns Hopkins University, I made collections of the fossil flora at a number of localities near Sweet Home. Subsequent study of these collections shows that the flora includes species of sequoia, hydrangea, laurel, sycamore, sweetgum, katsura, and cherry. Although the cherry may not be the only new species in this flora, it is singled out for attention here because its remains are particularly well preserved, showing distinctive, identifying features.

Numerous fossil leaves and seeds have been assigned to the genus *Prunus*, which includes the cherries and plums. Of all these, only a handful, perhaps 20 or 30, may be considered authentic. Most of the species are leaf-species, and of these, only two—*Prunus aucubaefolia* Massalongo (*2*, p. 415, pl. 28, fig. 2), from Miocene strata near Senigallia on the east coast of Italy, and *P. laurocerasus pliocenica* Laurent (*1*, p. 179, pl. 14, fig. 4), from the Pliocene of the Department of Cantal, France—appear to be assignable to the evergreen section of the racemed species of *Prunus*. Neither of these shows any glands. Consequently, so far as I know, the present specimens from Oregon are the first known fossils of the evergreen group showing glands within the blades of the leaves.

The leaves of deciduous and evergreen cherries are somewhat comparable in at least two features—venation and marginal dentition. The evergreen species, however, tend to be tougher in texture, and less toothed or entire, the teeth, as a rule, being coarser and sharper. The two groups differ markedly in another respect—the presence and position of prominent glands. In most of the deciduous cherries one or more conspicuous glands are present on the petiole, near its top. In

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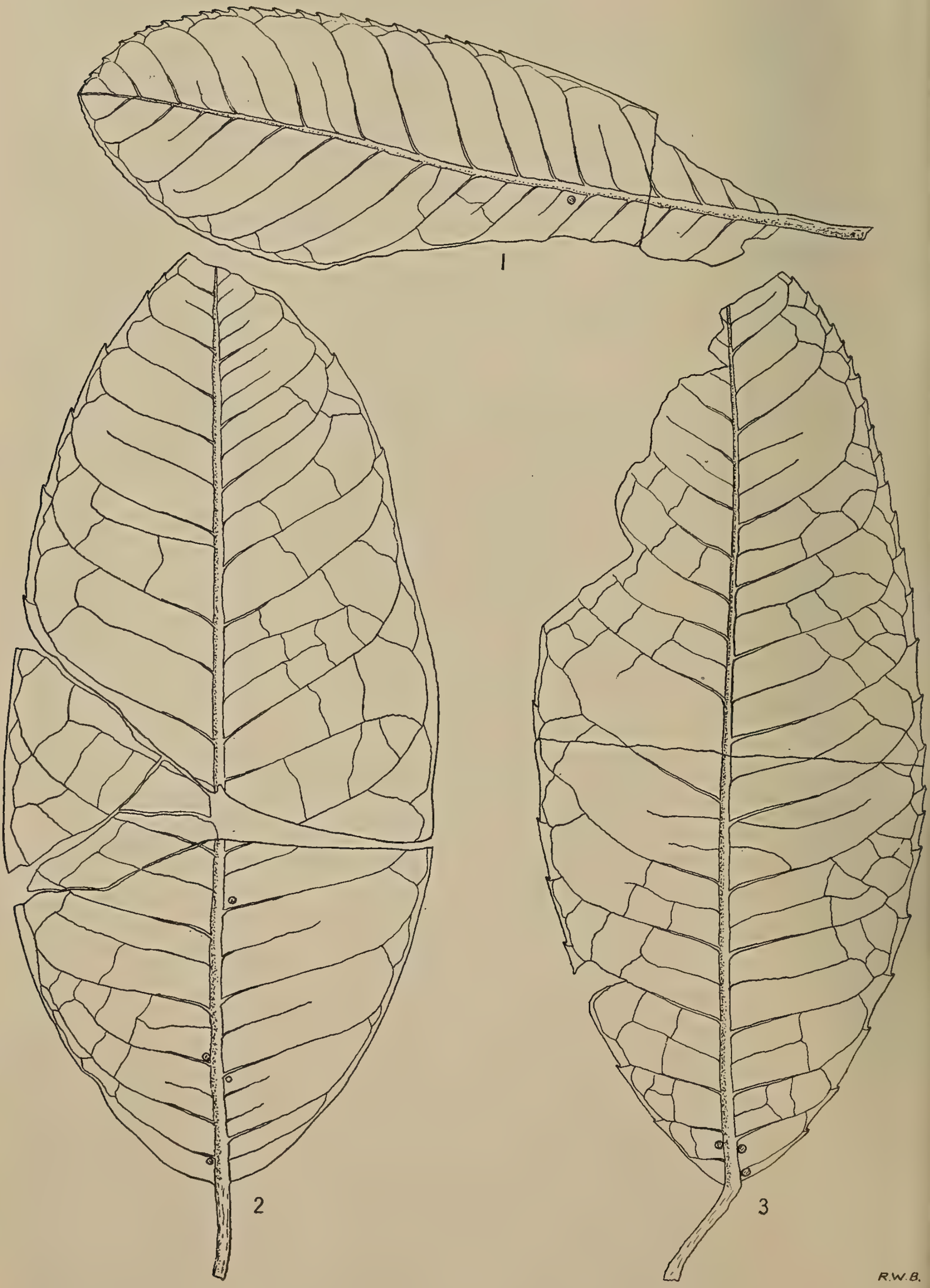
[1] Published by permission of the Director, U. S. Geological Survey. Received July 2, 1950.



Figs. 1–3.—*Prunus pristina* Brown, n. sp. Natural size.

the evergreen species, on the other hand, the few glands, if present, flank the midrib, either closely or distantly, in the basal part of the leaf-blade. The glands of one well-known species, *Prunus ilicifolia* Walpers, of California, are usually restricted to the basal margin. The function of these glands is unknown to me, but if the reader is interested in the general subject he may consult Sachs (*3*, pp. 183–186).

Other families of plants than the Rosaceae may have species that develop glands. In the tree-of-heaven (*Ailanthus altissima* Swingle), of the Simarubaceae, the tips of the large, basal teeth of the leaflets are prominently glandular and afford a ready means of identifying the tree. The marginal teeth of the poplars, willows, and many other trees may also be gland-tipped. The popular hedge plant, privet (*Ligustrum vulgare* Linnaeus), of the Oleaceae, has entire, opposite leaves that are glandular in the manner of the evergreen cherries. So also are the leaflets of *Trichilia*, of the Meliaceae. Minute, glandular dots, usually emitting aromatic odors, are sprinkled liberally over the leaves of the St. Johnsworts (Hypericaceae), eucalypts (Myrtaceae), oranges (Rutaceae), loosestrifes (Primulaceae), cottons (Malvaceae), wood-sorrels (Oxalidaceae), and many others.

ROSACEAE

Prunus pristina Brown, n. sp. Figs. 1–3

Leaves elliptic or slightly oblanceolate in outline, with cuneate bases and rounded to blunt pointed apexes, attaining a length of 15 cm and width of 6 cm. Margins coarse-serrate in whole or in part, or in some instances entire, the sinuses between the teeth scalloped. From the prominent midrib, at wide angles, arise equally-spaced, strong, camptodrome, secondary veins that make angular loops near the margins with the veins above. From these loops short veins run into the teeth. Between the secondaries are short intersecondaries that also arise from the midrib. Diagonal tertiary veinlets connect the secondaries and intersecondaries. Characteristic rounded glands of nearly uniform size, but displaying no further identifying details, are present in the basal halves of some of the leaves near the midrib. Many leaves are without glands. Scattered over these leaves, as in most fossil leaves, are also rounded spots of differing size that were caused by fungi, insects, or other agents. These must not be confused with the glands. Petiole stout, 2 cm long or more. No seeds recognizable as those of *Prunus* were found.

Locality: Along the T. Fell farm lane, in sec. 17, T. 13 S., R. 1 E., about 2¼ miles northeast of the bridge over the Santiam River at Sweet Home, Oreg. Specimens in the U. S. National Museum.

These leaves, at first sight, may be compared with the tough leaves of the Pacific madrone (*Arbutus menziesi* Pursh), of the Ericaceae, and particularly with those of the toyon (*Photinia arbutifolia* Lindley), of the Rosaceae. Although the madrone can be rejected at once by reason of its more diffuse secondary venation and finer, sharper teeth, when these are present, the toyon is more difficult to eliminate as a possible reference for the fossil leaves, because the venation and teeth of its leaves are more closely comparable to those of the fossils. However, in well-developed, large leaves of the toyon the secondary veins have a tendency to fork near the margin and one or both of these forks run directly into the marginal teeth. Moreover, the toyon has no glands.

The closest match I have so far found for the fossils among living species is *Prunus laurocerasus* Linnaeus and its varieties. This evergreen laurel-cherry is a native of southeastern Europe and southwestern Asia, ranging into northern Persia. It is cultivated in the United States at least as far north as Washington, D. C., and Roseburg, Oreg., where I have seen it. One of its associates in its native haunts is *Zelkova ulmoides* Schneider, a living representative of an ulmaceous genus that had a number of characteristic species in the western United States during the greater part of the Cenozoic era. Not any of these, however, has yet been found in the Oligocene localities at Sweet Home.

The native, evergreen cherries of the United States, Mexico, and the West Indies—*Prunus caroliniana* Aiton, *P. ilicifolia* Walpers, *P. lyoni* (Eastwood) Sargent, *P. axitliana* Standley, *P. brachybotrya* Zuccarini, *P. prionophylla* Standley, *P. myrtifolia* (Linnaeus) Urban, and others—fail, in one respect or another, to satisfy the requirements of reasonable identity with the fossils, and I conclude that *Prunus pristina* is not closely related to any of them.

Considering the associates of *Prunus pristina*—sequoia (of the coast redwood kind), hydrangea, sycamore, and sweetgum—I can visualize a valley lowland situation, perhaps not far from the sea. It was a well-watered land with a genial climate that did not have severe winters.

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(4) Staples, L. W. *Cubic pseudomorphs of quartz after halite in petrified wood.* Amer. Journ. Sci. **248**: 124–136. 1950.

BOTANY.—*New combinations in southwestern* Salix.[1] Carleton R. Ball, U. S. Department of Agriculture.

In preparing treatments of the genus *Salix* for certain manuals of botany, and for a final monograph, I find that the changes in status require publication and discussion. The descriptions permitted in most manuals are too brief to acquaint students with novelties, and adequate discussion and citation of specimens are impossible.

1. **Salix gooddingii** Ball and Its Glabrous-capsuled Variety

Salix gooddingii was published in 1905 (Bot. Gaz. **40**: 376), based on *Goodding 689* from what is now Clark County, Nev. This was a somewhat immature, partially insect-parasitized, and unusually pubescent specimen. Misled by foliar immaturity, and by the dense pubescence of both vegetal and pistillate floral organs, I assigned the new species wrongly to section *Longifoliae* (sandbar willows) instead of to section *Nigrae* (black willows). A specimen that should have been made the staminate type, *Goodding 719*, was overlooked entirely. These two errors were brought to my attention later by Prof. W. W. Rowlee and were acknowledged in a second paper on *S. gooddingii* (1921). That early experience taught me never again to base a new species on a single collection, a fact well worth learning.

In the paper of 1921, the species was redescribed and was illustrated by 3 photographs of Colorado Valley trees. The description was broadened to include in the species the glabrous-capsuled expression of the plant, as Schneider had done in 1918 and 1919. When accumulating material of both forms indicated that the glabrous-capsuled plant should be recognized as a variety, it was assumed that *S. nigra* var. *vallicola* Dudley (in Abrams, *Flora of Los Angeles and vicinity*: 100. 1904) represented this variety. Abrams had described the capsules as "glabrous or more or less pubescent." Britton, in raising Dudley's variety to specific rank as *S. vallicola* (Dudley) Britton (in *North American trees*: 184. 1908), described the capsules simply as "glabrous." The writer overlooked the fact that, in spite of these descriptions, the type specimen Abrams had cited (*Abrams 3256*, from Orange County, Calif.) actually had pubescent capsules. Under taxonomic rules, the type specimen, rather than the published description, governs the application of a name. Hence, both *S. nigra* var. *vallicola* Dudley and *S. vallicola* (Dudley) Britton are synonyms of *S. gooddingii* Ball.

Because of the erroneous assumption that var. *vallicola* was a glabrous-capsuled variation, large numbers of collections with glabrous ovaries and capsules have been determined as *S. gooddingii* "var. *vallicola* (Dudley) Ball," but, by oversight, that combination never has been published. In consequence of this series of errors, it now becomes necessary to publish this variety under a new and different name.

Salix gooddingii Ball var. **variabilis**, n. var. A specie differt ovariis capsulisque glabris. Distinguished from the species by ovaries and capsules glabrous. In the species, the ovaries are always more or less densely pubescent and the young capsules also are pubescent, but in age the capsules tend to become glabrate or glabrous.

The pubescence or puberulence of vegetal organs (twigs, budscales, petioles, midribs, and blade bases) is variable in both variety and species. In general, these organs in the typical form are more pubescent and retain the hairiness longer. In the variety they usually are pubescent or puberulent only while young and generally become glabrate soon and entirely glabrous later. However, exceptions occur in both species and variety. Hairiness varies with the stage of de-

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[1] Received July 10, 1950.

velopment of the various organs. Staminate specimens add to the difficulty of determination, as they have no ovaries or capsules to reveal pubescence. They must be assigned to the species or to the variety accordingly as one or the other occurs exclusively or commonly in the locality. More abundant hairiness probably is influenced by the higher temperatures characteristic of the more southern latitudes and lower altitudes occupied by the species. Although no hard and fast lines can be drawn between species and variety, the wide difference between the more extreme expressions still indicate that a varietal separation should be helpful to students.

Both species and variety are found commonly as shrubs to small or midsized trees 7–40 feet (2–12 meters) tall. Larger trees of both, 50-60 feet (15–18 meters) high, are found throughout their ranges, and very large trees, 70-80 feet (21–24 meters) in height, occur occasionally. The combined range of the two is from southern California eastward to western Texas, including adjacent Mexico and southern Utah and Nevada, with a long finger extending northward through the Central Valley of California as far as Shasta County.

Typical *S. gooddingii* has its most abundant and practically exclusive distribution in the lower part of the Colorado River Valley. This area extends southward from Washington County in southwestern Utah and Clark County in southeastern Nevada through the western parts of Mohave and Yuma Counties in Arizona, and the eastern parts of San Bernardino and Riverside Counties and all of Imperial County in California, to the Gulf of California in the States of Sonora and Baja California in adjacent Mexico. The variety is practically absent from this area. The species extends sparingly westward, with the variety, to Orange and San Diego Counties of California and western Baja California in Mexico. Northward, it occurs more sparingly, with the abundant variety, in the Central Valley of California to Kern and Fresno Counties, with one known occurrence in Yolo County.

S. gooddingii occupies an area of relatively low base level. It occurs at sea level to as much as 150 feet below in the Salton Sink of Imperial County. Throughout its range in southern California and adjacent Arizona and Mexico, and also in the Central Valley, it occurs at elevations of only a few hundred feet. In the mountains of these areas, however, it may reach elevations of 2,000 feet (600 meters) and rarely to 2,800-3,000 feet (840-900 meters) in Nevada and Utah.

Variety *variabilis*, on the other hand, is absent or relatively rare in most of this area of low base level, although it occurs at sea level or below in the Death Valley of Inyo County and commonly at altitudes of a few hundred feet in the Central Valley as far north as Shasta County, Calif. Its large area of exclusive occurrence is eastward across Arizona, southern Utah, New Mexico, and western Texas, with adjacent portions of the States of Sonora and Chihuahua in Mexico. In the mountains of these States it ascends to 4,500 or 5,000 feet (1,350-1,500 meters) and rarely to 5,500 or 6,500 feet (1,650 or 1,950 meters) in southern Arizona.

SPECIMENS CITED. For the western area, where both species and variety occur, it seems desirable to cite specimens of each. Those listed are in the following herbariums: Carleton R. Ball (CRB); U.S. Forest Service (FS); and U.S. National Herbarium (USN). Where the labels bear collection numbers the date is not cited here, except in some cases where the same numbers were used in successive years. For convenience of students, the specimens are listed by counties in each State, as counties are shown on most maps whereas many creeks, small lakes, canyons, mountains, and small towns are not. The full name of the collector is given in the first listing and only the surname thereafter. Specimens of the species are cited first, then those of the variety. Listings are from east and south to west and north.

Salix gooddingii. Arizona. Yuma County: Yuma, *Carleton R. Ball 1740* (old capsules glabrous), *1901* (old capsules pubescent) (both CRB, USN); Yuma Desert, *Aven & Ruth A. Nelson 1291* (USN); Yuma, E.O.Wooton, April 21, 1913 (USN). Yuma-Mohave County Boundary: Alamo Crossing of Bill Williams River, *Leslie N. Goodding Sal.-88*, in 1938 (CRB). Mohave County: Topock, Colorado River, *E.A. Goldman 2970* (USN); Willow Beach, Black Mountains., *Russell K. Grater S 1, S 2, S 3*, in 1938 (CRB); 8 miles above Pierce's Ferry, *Marcus E. Jones 5077 u* (USN); Beaver Dam Wash Beaver Dam (Littlefield), *Constant H. Robinson 39* (CRB); near Petrified Springs, Littlefield, *Ivar Tidestrom 9236* (CRB, USN). County unknown: Beaver Creek (several in Arizona); B. E. Fernow, August 1896 (USN, as *S. fluviatilis*).

Utah. Washington County: St. George, alt.

900 meters, *W. W. Eggleston 14773* (USN); Leeds, *Goodding Sal.-17*, in 1938 (CRB, not var. *vallicola* as determined); Virgin River 3 miles northwest of Hurricane, alt. 2,800 feet, *Bassett Maguire & H.L. Blood 1317*, *1317a* (CRB); along Santa Clara Creek, St. George, *Tidestrom 9276* (USN).

Nevada. Clark County (formerly part of Lincoln County): Muddy Creek (River), *Goodding 689*, in 1902 (CRB, pist. type); Rioville, Colorado River, *Goodding 719*, in 1902 (CRB, stam. type; USN); Muddy Creek ("Lincoln County"), *P. B. Kennedy & Goodding 41* (CRB); Bunkerville, *Tidestrom 9200* (USN), *9202* (CRB, USN).

California. Imperial County: Near Calexico, G. O. Abrams, April 1910 (USN); end of ferry, Fort Yuma, *Ball 1941* (CRB); 22 km north of Brawley, *Mrs. H. P. Bracelin 609* (CRB); near bridge over New River, 7.5 meters below sea level, *Bracelin 611*, *612* (CRB); 6.5 km west of Calexico, *Bracelin 613* (CRB); Colorado River, Yuma Indian Reservation, *Agnes Chase 5517* (CRB, stipules glandular, fragrant); U.S. Field Station, Bard, *Goodding & Charlotte Goodding Reeder 40* (CRB); San Bernardino Ranch (Mexican Boundary Line), *Edgar A. Mearns 735*, *1992* (USN); San Pedro River (same), *Mearns 1110* (USN); San Bernardino River (same), *Mearns 2543* (USN); Fig-Tree John's Spring, Salton Sea, 150 feet below sea level, *Munz, Street, & Williams 2342* (USN); Salton Basin, *S.B. Parish 8092a* (CRB); Unlucky Lagoon (Mexican Boundary Commission), *L. Schoenfeldt 2918* (USN); Bard, *H.L. Westover 1*, *2*, in 1913 (CRB, USN); *Westover 3*, in 1919 (USN). San Diego County: Bernardo, San Dieguito River, *LeRoy Abrams 3371* (USN); Pine Valley, *Mearns 3977* (USN). Orange County: Santa Ana River, near Orange, *Abrams 3256* (USN); Rancho Santa Ana, near River, *Carl B. Wolf 2950*, *2955* (CRB). Riverside County: Cameron Lake, Colorado Desert, T.S. Brandegee, March 28, 1901 CRB); Thousand Palms, Carl Epling, March 27, 1927 (CRB); 1000-Palm Canyon, Colorado Desert, *H. De Forest 1*, in 1932 (CRB); north of Elsinore, *Philip A. Munz 12032* (USN); near State Inspection Station, on way to Blythe Bridge, *Wolf 3035* (CRB). San Bernardino County: Beside Mohave River, 1.5 km north of Barstow, *Bracelin 587*, *588* (CRB); Fort Moh(ave), J.G. Cooper, March 25, 1861 (CRB, USN); along Mohave River, Cooper (USN, without other data); San Bernardino, *P.B. Kennedy 1672* (CRB); Colton, *Jones 3195* (USN); Santa Ana River, San Bernardino, *Alfred Rehder 165* (USN); near Mohave River, 5 miles west of Barstow, *W. A. Setchell & Victor Duran 10* (CRB); Barstow, *Tidestrom 9687* (USN); San Bernardino, *George R. Vasey 566* (USN). Kern County: Beside Old River Road, 32 km southwest of Bakersfield, *Bracelin 576*, *577* (CRB). Fresno County: San Joaquin River at Friant, *Albert E. Thompson 1012* (CRB). Yolo County: River bank near Madison, *A. A. Heller 5419* (USN).

Mexico. Baja Calfiornia: Seven Hills, on the Salton River, *Mearns 2869*, *2877* (USN, stam.).

Variety *variabilis*. Utah. Grand County: Moab, *Goodding Sal. 33*, *Sal. 39*, in 1933 (CRB). San Juan County: Augusta Natural Bridge, 48 miles west of Blanding, *Goodding Sal. 33*, in 1939 (CRB); San Juan River, 2 miles east of Mexican Hat, *Maguire 20167* (CRB). Washington County: Arizona Strip, *Bernell McAllister 60* (CRB); Zion National Park, *A. M. Woodbury 30* (USN). County unknown: Frement's Expedition to California, 1845–47 (USN, in ink on label is "Utah"; in faint pencil is "402a. Calif.").

Nevada. Nye County: Ash Meadows, *F. V. Coville & Frederick Funston 2145* (USN).

California. San Diego County: San Luis Rey River bottoms, southeast of Bonsall, *Chas. B. Fiker 3349B* (CRB). Riverside County: Near spring at Twentynine Palms, Colorado Desert, *Clary Herbarium 920* (CRB); Palm Canyon, *Ivan Johnston 1056* (USN); north of Elsinore, *Munz 12032* (CRB); Diablo Canyon, near Clary's Coral Reef Ranch, Colorado Desert, *Carl W. Sharsmith 14* (CRB). San Bernardino County: Along Mohave River, Helendale, *Bracelin 590*, *593* (CRB); Barstow, Frank W. Johnson, April 23, 1910 (USN). Inyo County: Mitchell Ranch, Resting Springs Valley, *Coville & Funston 262* (USN); Furnace Creek Ranch, Death Valley (cultivated), *Coville & Funston 469* (USN); Big Spring, Shoshone, *Coville & M. French Gilman 454* (USN); Black Rock Springs, *Mark Kerr 96* (CRB).

Central Valley of California. Kern County: Tulare Plains about 10 miles south of Bakersfield, *Coville & Funston 236* (USN). Tulare County: Hanford, *Alice Eastwood 3846*, *3851* (USN); Visalia, *Eastwood 34* (USN); Kaweah River, between Ash Mountain and Three Rivers, *Harold E. & Susan T. Parks 01037*, *01070*, *01071* (USN) (all CRB); Kaweah River north of Visalia, *Thompson 1042* (CRB). Fresno County: Fresno, *George L. Fisher 79* (USN);

Centerville, Kings River Delta, *H. E. Parks 0932* (CRB); beside San Joaquin River at Friant, *Thompson 1013* (CRB). Madera County: Fresno River, J. W. Congdon, June 21, 1903 (USN); Power House 1, San Joaquin Forest, Ernest G. Dudley, November 1911 (CRB); shore of Bass Lake (Reservoir), alt. 3,400 feet, *Thompson 1063* (CRB). Merced County: East of Los Banos, *Bracelin 702* (CRB). Stanislaus County: Denair, *Paul A. Harvey 1, 3*, in 1940 (CRB). San Joaquin County: Tom Payne's or Paradise Cutoff, Tracy Pike, about 15 miles south of Stockton, *Ball 1929* (CRB, USN). County unknown: Sacramento Valley, U. S. Exploring Expedition under command of Capt. Wilkes (USN, no date). Sacramento County: Sacramento, *Lester F. Ward 89* (USN). Amador County: Sutter Creek, Ione, *C. H. Merriam 4*, in 1905 (USN); South Jackson, *George Hanson 198* (USN). Yolo County: Rumsey, *C. F. Baker 2936* (USN). Nevada County: Penn Valley, west of Grass Valley, *Heller 13183* (USN). Lake County: Shore of Clear Lake in Highland Park, *Milo S. Baker 5351, 5357* (CRB); bank of Cache Creek, *H. N. Bolander 2678* (USN); near Clear Lake, *John Torrey 490* (USN). Butte County: near U. S. Rice Experiment Farm, Biggs, *Ball 1820* (USN), *1821* (USN), *1822, 1824, 1839* (all CRB); along Chico Creek, Chico, *Ball 2069, 2071, 2072* (CRB, USN); Chico-Oroville Road, 12 miles from Chico, *Heller 11262* (USN). Tehama County: Red Bluff, *L. E. Smith 596, 599, 600, 668, 669* (all USN): Shasta County Redding, bridge at north end of town, *Bracelin 481* (CRB, USN); Reed Creek, *Smith 610* (USN).

Mexico. Baja California: La Paz, *Edward Palmer 77*, in 1890 (USN, as *S. bonplandiana*); Gardener's Laguna, *L. Schoenfeldt 2895*, in 1894 (USN). State uncertain: Lake Polonius (?), Mimbres Valley, *Mearns 184*, in 1892 (USN). Sonora: Alamo, near Magdalena, *Kennedy 7030*, in 1925 (USN); vicinity of Hermosillo, *Rose, Standley, & Russell 12391, 12501*, in 1910 (USN); vicinity of Navajoa, *Rose et al. 13156*, in 1910 (USN); vicinity of Magdalena, *Rose et al. 15113*, in 1910 (USN); Río Bavispe, near Colonia Oaxaca, *Stephen S. White 428*, in 1938 (CRB); Arroyo Carretas, Carretas, border of Chihuahua and Sonora, Municipio de Janos, *White 2615*, in 1939 (CRB); Río Bavispe, Bavispe, *White 2881*, in 1940 (CRB); Horconcitos, Río Hauchinera (Río de Bavispe area), *White 2973*, in 1940 (CRB); Río Fronteras, San Rafael, *White 3862*, in 1941 (CRB); Colonia Morelos, *White 4102*, in 1941 (CRB). Chihuahua: Southwest of San Ysidro, Dist. Guerrero, *Ynes Mexia 2534*, in 1929 (CRB); Santa Eulalia Mountains, Wilkinson, in April 1888 (USN). *White 2615 and 4102*, listed above in Sonora, may possibly be from adjacent Chihuahua.

Bibliography.—Because the material comprising *S. gooddingii* and its variety *variabilis* has been presented and discussed under so many different names, it seems desirable to give a fairly full bibliography of these treatments. Where these publications cover southern or central California and the adjacent portions of Nevada, Arizona, and Mexico, they may be discussing either the species or the variety, or both.

S. gooddingii n. sp., Ball, Bot. Gaz. **40**: 376. 1905; Ball, Bot. Gaz. **72**: 227–234, *figs. 2–4.* 1921; Schneider, Bot. Gaz. **65**: 12–13. 1918; Schneider, Journ. Arnold Arb. **1**: 9. 1919; Tidestrom (*Flora of Utah and Nevada*), Contr. U. S. Nat. Herb. **25**: 135. 1925; Baker, *Partial list of seed plants of the North Bay Counties:* 22. 1934, rev. ed. 28. 1945 (mimeographed); Goodding (*Willows in Region VIII*), U. S. Dept. Agr. Soil Cons. Serv. Reg. Bull. **66**: 6–7, *4 illus.* 1940; Kearney and Peebles (*Flowering plants and ferns of Arizona*), U. S. Dept. Agr. Misc. Publ. **423**: 219. 1942; Little (*Checklist of the native and naturalized trees of the United States*), U. S. Dept. Agr. For. Serv. (mimeographed): 263. 1944.

S. nigra, as interpreted by numerous authors,[2] not Marshall, in floras and forest floras of varying geographic coverage, so far as these apply to southwestern areas from western Texas westward. These works are not cited here in full, only author and year being given. For better understanding, they are grouped by size of area covered, as local, State-wide, regional, and national. Coulter, *Botany of western Texas*, is listed as regional because of the large area covered. *Local:* Greene, 1894; Hall and Hall, 1913; Jepson, 1901, 1911; Merriam, 1893; Parish, 1913. *Statewide:* Bebb, 1879 and 1880; Eastwood, 1905; Jepson, 1909, 1909, 1910; Wooton, 1913; Wooton and Standley, 1915. *Regional:* Coulter, 1894; Howell (Thomas), 1902; Sudworth, 1908. *National:* Sargent, 1896, 1905; Sudworth, 1897, 1898.

S. nigra Marsh., var. *vallicola* Dudley, in Abrams, *Flora of Los Angeles and vicinity:* 100. 1904, and suppl. ed. 100. 1911; Jepson, *Man. Flowering Pl. Calif.* 263. 1925; Pickwell and Sayle (*Trees of valley and foothill*), in West. Nature Study **1**: 199, *fig. 90*, 206. 1930.

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[2] In 1921 I used the commonly accepted but both inaccurate and misleading form of citation: "*S. nigra* of numerous authors, not Marsh." when I should have written: "*S. nigra*, as interpreted by numerous authors, not Marsh." Schneider, in 1918 and 1919 (l.c.), similarly had ascribed the publication of an "*S. nigra*" to each of nine authors, when they merely were wrongly interpreting *S. nigra* Marshall. The same error was repeated by me in 1923 (in Abrams, *Illus. Flora of the Pacific States* **1**: 490).

S. nigra Marshall, var. *venulosa* (Andersson) Bebb, n. comb., in Coville (*Botany of the Death Valley Expedition*), Contr. U. S. Nat. Herb. **4**: 199. 1893; as interpreted by Bebb (*Review of the willows of California*), Bot. Gaz. **16**: 102. 1891 (see discussion below).

S. nigra Marshall, var. *wrightii*, as interpreted by Bebb, Bot. Gaz. **16**: 102–103. 1891; as interpreted by Bebb, in Coville, Contr. U. S. Nat. Herb. **4**: 200. 1893; as interpreted by Coulter (*Botany of western Texas*), in part, Contr. U. S. Nat. Herb. **2**: 419. 1894, not Andersson (see discussion below).

S. vallicola (Dudley) Britton, *North American Trees* 184, fig. 1141. 1908.

S. wrightii, as interpreted by Wooton and Standley (*Flora of New Mexico*), Contr. U. S. Nat. Herb. **19**: 160. 1915, not Andersson (see discussion below).

Andersson first published his variety *venulosa* in 1867 (*Monographia salicum*) as a variety of *S. nigra* Marsh., subspecies *longipes* (Shuttleworth), and described the New Mexico plant as having leaves paler to glaucescent beneath. *S. longipes* is the southeastern plant with glaucous leaves now known as *S. caroliniana* Michx. and belongs to section *Bonplandianae*. As its range extends west only to southern Texas, a New Mexico plant with glaucescent leaves would represent either *S. bonplandiana* (section *Bonplandianae*) or *S. wrightii* (*S. amygdaloides* var. *wrightii*) of section *Triandrae*.

When Bebb listed *S. nigra* var. *venulosa*, or var. *wrightii*, as occurring in California, he was dealing with *S. gooddingii* or its variety *variabilis*, because neither *S. bonplandiana* nor *S. wrightii* occurs as far west as California. In 1891, under *S. nigra*, he states that across New Mexico and Arizona it takes on the character of variety *venulosa* and that variety *wrightii* is the same thing. These statements show conclusively that Bebb did not then distinguish between the green-leaved species, *S. nigra* and the then unnamed *S. gooddingii*, and the glaucous-leaved species, *S. bonplandiana* and *S. wrightii*.

Wooton and Standley (*Flora of New Mexico*), in 1915, under their interpretation of *S. wrightii* Andersson, state that the "leaves are light green, of about the same color on both surfaces." Under *S. nigra* they say: "It is very probable that further study of what is here considered *S. nigra* in New Mexico will show that it belongs to *S. wrightii*, which is the common plant of the type." Apparently they were dealing with *S. gooddingii* variety *variabilis* in both cases and did not recognize var. *wrightii* at all because they limit *S. amygdaloides* to the extreme northern part of the State, where it does occur but variety *wrightii* does not.

Separation from S. nigra. In the Southwest, *S. gooddingii* and its variety *variabilis* are the counterparts of the abundantly occurring *S. nigra* and its varieties in the eastern half of the United States. *S. nigra* and its southwestern variety *lindheimeri* Schneider are marked by twigs light brown to dark brown and glabrous or sometimes puberulent; leaves smaller and green to dark green; stipules without glands on the upper (inner) surface, or occasionally a few such glands on var. *lindheimeri*; and capsules shorter in *S. nigra* but sometimes as large (as those of *S. gooddingii* in variety *lindheimeri*, but always glabrous in both.

S. gooddingii and variety *variabilis*, on the other hand, have twigs yellow to yellowish and more of less pubescent-puberulent (especially when young) to glabrous; leaves mostly yellowish green and larger (those on vigorous shoots up to 15–19.5 by 2–3 cm); stipules commonly with abundant fragrant glands on the upper surface; and capsules commonly to 6.5 or 7 mm long and ovaries and capsules always pubescent in *S. gooddingii* but glabrous in variety *variabilis*.

In western Texas (north to south), variety *variabilis* is found on the Canadian River in Hemphill County in the northeastern Panhandle, within the range of both *S. nigra* and variety *lindheimeri*. On the headwaters of the Red River, it reaches Deaf Smith and Donley Counties in the southern Panhandle, Donley County being within the range of variety *lindheimeri*. In the Staked Plains (Llano Estacado), it reaches Hale and Lubbock Counties in the Brazos River drainage, Hale County being in *lindheimeri* territory. Farther south and east it occurs in Tom Green County of the Concho River drainage, occupied also by *S. nigra*. It occupies also most of the mountainous counties in the large triangular area south of New Mexico to as far east as Pecos and Brewster Counties, an area where neither *S. nigra* nor variety *lindheimeri* is found. It has one sporadic occurrence in Starr County, in far southern Texas, where both *S. nigra* and variety *lindheimeri* occur. This occurrence probably resulted from flotation down the Rio Grande.

All known Texas specimens showing the distribution of variety *variabilis* and of *S. nigra* and its variety *lindheimeri* are cited in Dr. Lundell's forth-coming *Flora of Texas*.

The eastern extension of variety *variabilis* from New Mexico into western Texas is interesting ecologically. In northeastern New Mexico it crosses the divide east ofthe Rio Grande and the Pecos River and extends down the headwater streams of the Canadian and Red Rivers, of Mississippi River drainage. In east-central and southeastern New Mexico it crosses the divide east of the Pecos River and extends down the headwaters of the White (Brazos) and Concho (Colorado) Rivers, of the Gulf drainage. It occurs along the Rio Grande and the Pecos River and their tributaries, in southwestern Texas, as far east as Brewster and Pecos Counties, with the one sporadic occurrence noted far down the Rio Grande in Starr County.

On the other hand, *S. nigra* and its variety *lindheimeri* have not been able to cross these divides between the eastward-flowing rivers and southward flowing Rio Grande and Pecos River. In fact, they apparently have not been able to ascend any of these streams to their headwaters. Undoubtedly downstream spread is accomplished with comparative ease and upstream spread with relative difficulty, but why were both species not affected equally when they reached these divides? Did the long-recurring eastward drives of large herds of grass-fed cattle from the Southwest to the frontier Kansas railroads help the eastern spread of western willows? Cattle browse freely on willows, and a piece might be carried far in a steer's mouth. Likewise a stem regurgitated during cud-chewing by animals bedded down for the night near a spring or stream might be dropped and trampled into the mud in the movements of the following morning. Only the few returning cowboys and chuck wagons traveled in the reverse direction.

2. **Salix ligulifolia** (Ball) Ball. (*S. lutea* Nutt., var. *ligulifolia* Ball)

This willow has been so differently treated by so many writers that it seems desirable to review its history, rewrite its description, and cite authenticated specimens to show its recognized wider distribution. It is chiefly in California and Oregon that the known range has been considerably extended. Specimens cited in 1921 are not relisted here.

Salix cordata, as interpreted by Bebb, in Brewer and Watson, *Botany of California* **2**: 85. 1880 (preprinted, with same pagination, as Bebb, *Willows of California*. 1879); as interpreted by Bebb, in Coulter, *Manual of the botany of the Rocky Mountain region:* 335. 1885 (as to distribution in most of the Rocky Mountain area); by Bebb (*Review of the willows of California*), Bot. Gaz. **16**: 104. 1891; and by Ball, in Coulter and Nelson, *New manual of the botany of the Central Rocky Mountains:* 132. 1909 (as to distribution in the Rocky Mountains and westward), not Muhlenberg.

S. cordata Muhl., var. *mackenziana*, as interpreted by Bebb, in Brewer and Watson, *Botany of California:* 286. 1880, and preprint **2**: 86. 1879 (so far as most occurrence in California is concerned); and by Bebb, in Coulter, *Manual of the botany of the Rocky Mountain region:* 335. 1885 (so far as occurrence in most of the Rocky Mountain region is concerned), not Hooker.

S. cordata Muhl., var. *watsoni*, as interpreted by Wooton and Standley (*Flora of New Mexico*), Contr. U. S. Nat. Herb. **10**: 159. 1915 (so far as southern distribution is concerned), not Bebb.

S. ligulifolia Ball, in litt. —?, Schneider, Journ. Arnold Arb. **2**: 188(–189). April 1921 (nomen nudum).

S. ligulifolia Ball (*S. lutea* var. *ligulifolia* Ball), n. comb., apud Smith (*Willows of Colorado*), Amer. Midl. Nat. **27**: 236(–237), January 1942; Kearney and Peebles (as synonym of the variety, see below); Thompson, Albert E., *Salix ligulifolia* Ball, *The strap-leaved willow and its relatives in the central Sierra Nevada:* 6 pp. (typed, not published). 1942; rev. ed. 1943.

S. lutea Nutt., var. *ligulifolia*, n. var., Ball, Bot. Gaz. **71**: 428(–430). June 1921; Ball, in Abrams, *Illustrated flora of the Pacific States* **1**: 494. 1923; Tidestrom (*Flora of Utah and Nevada*), Contr. U. S. Nat. Herb. **25**: 136. 1925; Kearney and Peebles (*Flowering plants and ferns of Arizona*), U. S. Dept. Agr. Misc. Publ. 423: 220. May 1942 (*S. liqulifolia* Ball as synonym).

Frutex; ramulis veterioribus fuscis ferrugineis aut nigrescentibus, juvenioribus flavescentibus aut fuscentibus saepe pubescentibus; foliis liguliformibus anguste lanceolatis aut anguste oblongolanceolatis subtus glaucis; capsulis 4–5.5 mm longis glabris.

Shrub with clustered stems, commonly 1–3 meters tall, rarely 4–5 meters (Plumas County) general color effect dark green; bark dark gray; branchlets varying with age, the new growth yellowish and generally puberulent, summer-grown twigs yellowish to brown and often pubescent to densely so, 1-year and 2-year twigs brown or reddish brown to blackish, often shining, mostly glabrous or the 1-year retaining (or renewing) previous pubescence; buds ovate-lanceolate, 5–10 mm long, acute or obtusish, colored and clothed as the twigs, often drying black; stipules semiovate and acute to semilunate and obtuse, 4–10 mm long, or to 15–18 mm on vigorous shoots, entire to serrulate, mostly glabrous, glaucous beneath; petioles stoutish, 5–10 mm long, yellowish to brown, pubescent to glabrous; leaves midsized, ligulate, or lanceolate, or oblong-lanceolate (narrowly oblanceolate while unfolding), 5–10 cm long by 1–2 cm wide, or 11–13.5 by 2.5–3 cm on vigorous shoots, acute or very short-acuminate at apex, broadened, rounded, truncate, or cordate at base, subentire or more or less serrulate or glandular-serrulate, the largest sometimes toothed near base, reticulate veiny on both sides, especially beneath, dark green above, glaucous to white-glaucous beneath, glabrous after unfolding or the whitish midrib puberulent above on the basal portion.

Aments coetaneous or somewhat precocious, the staminate slender, 2–3 cm long, sessile and naked or with 1–2 small bracts at base; pistillate 2–4 or 5 cm long, to 1.4 cm wide in fruit, subsessile or on leafy-bracted peduncles 5–10 mm long; scales elliptic-oblong, obtusish, brownish, drying black, densely white-tomentose or the apex becoming glabrate externally; stamens 2, filaments glabrous, free; capsules small, lanceolate or ovate-lanceolate, 4–5.5 mm long, glabrous; pedicels mostly 1.5–2.5 mm long, rarely 3.5 mm, glabrous; styles 0.3–0.5 or 0.7 mm long, mostly entire; stigmas short, entire, notched, or bifid; gland short. The flowering period covers late April and May, with fruiting continued thereafter.

Salix ligulifolia is a clumpy shrub of mountain streams and meadows, at altitudes ranging from 3,000 to 9,000 or rarely 9,500 feet (900–2,700 or 2,850 meters) but occurring most commonly at altitudes of 4,000 to 7,000 feet (1,200–2,100 meters). It often is associated with *S. lasiandra* Benth. and *S. lemmoni* Bebb in the Sierra Nevada. It ranges from the Black Hills of South Dakota (Custer County), and the Laramie and Medicine Bow Mountains of southeastern Wyoming, southward across Colorado and New Mexico, westward in Arizona, and northward in the Sierras of California from Tulare County to Plumas and Tehama Counties. There is sparse or sporadic occurrence in southern Utah and Nevada, and in Klamath, Jackson, and Josephine Counties of extreme southern Oregon also.

It is the southwestern representative of the section *Cordatae*, as *S. lutea* Nutt. is the western, *S. mackenziana* (Hooker) Barratt the northwestern, and *S. rigida* Muhl. (*S. cordata* Muhl., not Michx.) the eastern. It parallels *S. rigida* most closely in the variability of hairiness on the vegetal organs. What one finds depends much on the stage of their development when observed or collected. The ranges of the dark-twigged *S. ligulifolia* and *S. mackenziana* scarcely overlap at all, but yellow-twigged *S. lutea* and its varieties occur throughout much of the ranges of both the others.

The distribution was well indicated by the specimens cited in 1921, except for California and southern Oregon. California was credited then with a single collection and Oregon with none. Below are cited those recognized by the writer since 1921.

WYOMING. Laramie County: Sybille Creek, *Elias Nelson 672*, in 1901 (CRB). Albany County, Woods Creek, *L. N. Goodding 1432*, in 1903: (CRB); Sand Creek, *Aven Nelson 6965*, in 1900 (CRB); Laramie River, near Laramie, alt. 7,000 feet, *Louis C. Williams 2812*, in 1935 (CRB, and in USN as no. 2212).

COLORADO (alphabetical). Alamosa County: Alamosa, *Hazel M. Schmoll 1032*, *1033*, in 1924 (CRB). Archuleta County: San Juan National Forest, *S. Duval Anderson A 49½*, in 1925 (FS 50272½). Boulder County: Ward, alt. 9,150 feet, *Schmoll 601*, in 1922 (CRB). Conejos County: Conejos River, *Goodding Sal.-50A*, in 1938 (CRB). Costilla County: 10 miles west of LaVeta Pass, *Goodding & Leston Goodding Sal. 20–39*, in 1939 (CRB). El Paso County: near Colorado Springs, *E. C. Schneider J-1*, *J-4*, *NC-4*, *NC-6* *PS-3*, *WC-3*, *WC-5*, all in 1910 (all CRB); Beaver Creek, 3 miles west of Monument, *E. R. Warren 3*, *4*, on June 9, 1926 (CRB, USN). El Paso-Teller Counties: Pikes Peak Forest Reserve, S. J. Flintham, on September 2, —— (USN, as *S. lutea* var. *watsoni*); Pikes Peak region, alt. 6,750–9,500 feet, *I. M. Johnston 2779*, *2780*, *2781* (USN), *2782* (USN), *2783*, *2784*, *2785*, *2786*, in 1920 (all CRB). Gunnison County: Anthracite Creek, alt. 8,800 feet, *Warren 21*, in 1927 (CRB); Fitzpatrick Mesa, 2 miles west of Blue Creek, alt. 8,500 feet, *R. C. Rollins 1991*, in 1937 (CRB). Larimer County: La Porte, *Ernest C. Smith 660*, *818*, in 1935 *721*, *723*, in 1936 (all CRB) Rio Grande County: Vicinity of Monte Vista, *Schmoll 1040*, *1057*, in 1924 (CRB). Teller County: East of Divide, *J. H.*

Christ 213, in 1935 (CRB). Teller–El Paso Counties: See El Paso–Teller Counties, above. Weld (?) County: Chimney Rock, on Sand Creek, 50 miles north-northeast of Fort Collins, *Smith 1710*, in 1945 (CRB).

New Mexico. Catron County: Beaverhead Ranger Station, *Goodding & Goodding Sal.-5-39*, in 1939 (CRB). Colfax County: Cimarron Creek Soden and Baldy Meadow, *Goodding & Goodding Sal.-6-39*, in 1939 (CRB). Rio Arriba County: 81 miles north of Santa Fe, on road to Chama, *Goodding Sal.-54*, in 1938 (CRB); west slope of Sierra Nacimiento, *Goodding Sal.-83*, in 1938 (CRB, as *S. mackenziana* var. *macrogemma* Ball). Specimens from Grant, Lincoln, and Union Counties cited in 1921.

Utah. Kane County cited in 1921.

Nevada. Washoe County: Reno, *Ivar Tidestrom 10623*, in 1919 (CRB).

Arizona. County unknown: Beaver Creek, B. E. Fernow, in August 1896 (USN). Numerous specimens from east-central portion cited in 1921. Coconino County: Upper Oak Creek near Flagstaff, *H. J. Fulton 7166*, in 1930 (USN).

Oregon. Klamath County; Johnson Prairie, *Elmer I. Applegate 2472*, in 1898 (USN); south end of Lake of the Woods, *F. V. Coville 1205*, in 1902 (USN); 5 miles northeast of Fort Klamath, *Morton E. Peck 19722*, in 1937 (CRB); near creamery, Klamath Agency, Wood River, *F. A. Walpole 2217*, in 1902 (USN). Jackson County: Jackson Creek, ¾ mile west of Jacksonville, *L. R. Abrams & J. T. Benson 10261*, in 1924 (CRB, distr. as *S. lasiandra*); determined later by Ball as *S. mackenziana*); Medford, *H. B. Humphrey 2054*, in 1916 (CRB, as *S. mackenziana*); Gold Hill, *Walpole 149*, in 1899 (USN, too juvenile for complete certainty). Josephine County: Gravelly flood-plain, east fork of Illinois River, near Highway 199, *Carleton R. Ball & Harold E. Parks 01278*, in 1932 (CRB).

California (north to south). Tehama County: South fork of Battle Creek, 1.7 km northeast of Mineral, *Ball, Bracelin & Kautz 379*, in 1931 (CRB, USN). Plumas County: 1 mile southeast of Fowler Peak, *D. Axelrod 6791*, in 1934 (CRB); North Fork of Feather River, at Chester, *Ball, Bracelin, & Kautz 393, 394, 397, 398*, in 1931 (CRB, several sheets of each; USN). Butte County, Jonesville, *E. B. Copeland 621* and 3 unnumbered, on June 10, 18, and 20, 1931 (CRB); Copeland, in May 1938 (CRB). Placer County, French Meadows, American River, Tahoe National Forest, *L. S. Smith 3*, in 1931 (CRB). El Dorado-Placer Counties: Tahoe-to-Placerville Road, with *S. lemmoni*, *Emily Smith 14*, in 1933 (CRB). Tuolumne County (Yosemite National Park): Carl Inn, Big Oak Flat and Tioga Roads, *Ball, Bracelin, & Emily Smith 552*, in 1931 (CRB); same, *Smith 3a*, in 1933, (CRB); south fork of Tuolumne River, in west edge of park, *Albert E. Thompson 1195, 1197, 1199*, in 1941 (CRB). Mariposa County (mostly Yosemite National Park): Illilouette Canyon, alt. 1,940–1,970 meters, *E. B. Babcock 1058*, in 1912 (USN, as *S. cordata mackenziana*); Crane Flat on Big Oak Flat Road, *Ball, Bracelin, & Kautz 509*, in 1931 (CRB, USN); Big Creek, tributary of south fork of Merced River, just outside park, *Thompson 1105, 1106, 1109*, in 1941 (CRB); Wawona, *Thompson 1182*, in 1941 (CRB). Madera County: The Falls, Bass Lake, *Thompson 253, 255, 256, 257*, in 1939 (CRB); same, *Thompson 1008*, in 1941 (CRB); area of south fork of Willow Creek, *Thompson 1043, 1044, 1045, 1046, 1048, 1049, 1051, 1052, 1053, 1075, 1076, 1084, 1092, 1097*, in 1941 (all CRB); area of Big Creek, near Fresno Dome, and Beasore Meadow, etc., *Thompson 1099, 1122, 1123, 1205, 1206, 1214, 1217, 1219*, in 1941 (CRB). Fresno County: near shore of Hume Lake, *Thompson 255*, in 1939 (CRB); Indian Basin, Kings River Canyon Highway, *Thompson 259, 262, 264*, in 1939 (CRB); area of Sequoia Lake Dam, *Thompson 391, 396*, in 1940 (CRB); same, *Thompson 1029*, in 1941 (CRB); Huntington Lake, alt. 7,000 feet, *Thompson 929, 938*, in 1939, and *1172*, in 1941 (CRB). Tulare County: South end of Crescent Meadows, alt. 7,240 feet, *Mrs. H. P. Bracelin 802, 803*, in 1933 (CRB); Heather Lake Trail, alt. 7,500–7,600 feet, *Bracelin 807b, 808*, in 1933 (CRB).

3. **Salix lasiolepis** Bentham, var. **bracelinae**, n. var.

Salix irrorata, in part, as interpreted by Ball, in Coulter and Nelson, *New manual of the botany of the Central Rocky Mountains:* 132. 1909 (by twigs "or downy-puberulent" and by the Texas, and probably some of the New Mexico, distribution), not Andersson.

Salix lasiolepis Bentham, *Plantae Hartwegianae:* 355. 1857 (in part); Andersson, Öfv. Kon. Vet.-Akad. Förh. **15**: 118. 1858 (in part); printed simultaneously in Proc. Amer. Acad. Arts and Sci. **4**: 58. 1858 (reprinted as *Salices Boreali-Americanae:* 12); Andersson, in DC., Prodr. **16**(2): 264. 1868 (in part); Ball, in Abrams, *Illustrated flora of the Pacific States* **1**: 496. 1923 (in part). Goodding (*Willows in Region VIII*), U. S. Dept.

Agr. Soil Cons. Serv. Reg. Bull. **65**: 8, *illus.* 1940 (mimeogr.); Kearney and Peebles (*Flowering plants and ferns of Arizona*), U. S. Dept. Agr. Misc. Publ. **423**: 219. 1942; Schneider, Bot. Gaz. **65**: 31. 1918 (distribution in Mexico); Schneider, Journ. Arnold Arb. **2**: 187–188. 1921 (in part); Wooton and Standley (*Flora of New Mexico*), Contr. U. S. Nat. Herb. **19**: 159. 1915.

A forma typica species differt foliis linearibus, lineari-ellipticis, lineari-lanceolatis, aut lineari-oblanceolatis. Shrub 2–5 or 6 meters, or small tree 5–8 or 9 meters (17–30 feet) tall, with clustered stems and grayish bark; twigs mostly stoutish, the seasonal yellowish and pubescent to puberulent, the 1-year yellowish to brownish and often pubescent or puberulent before the epidermis peels off in the spring and sometimes becoming puberulent thereafter, the older chestnut-brown to dark-brown and glabrate to glabrous; buds stout, 2–6 mm long, or 6–10 mm long and 2–4 mm wide on vigorous shoots, colored and clothed much as the supporting twigs; stipules 2–4 or 8 mm long, obliquely lanceolate, ovate, or sublunate, sometimes serrulate, glaucous beneath.

Leaf-petioles stoutish, 5–10 or 15 mm long, yellowish and pubescent while young, becoming brownish and glabrate-glabrous with age; blades very narrow, linear-elliptical, linear-lanceolate, linear-oblanceolate, or sometimes narrowly oblong, 6–10 cm long and 0.8–1.5 cm wide, or to 11–15 cm by 1.5–2 cm on vigorous shoots, narrowed at base, acute or short-acuminate at apex, subentire to irregularly undulate-denticulate or undulate-serrulate and somewhat revolute at margins, gray-pubescent while unfolding, usually becoming glabrate to glabrous with age, dark green and somewhat shining above, densely glaucous and reticulate beneath, the yellowish midrib prominent on both sides and often minutely puberulent above in maturity.

Aments precocious, often appearing in December-January in the axils of the old leaves, especially southward, subsessile at first, 3–7 cm long; the staminate 1.2 cm wide, stamens 2, filaments glabrous, usually united for $\frac{1}{4}$ or more of their length; pistillate 1–1.4 cm wide, the peduncle in fruit 2–5 or 8 mm long and bearing 2–4 tiny bract-like leaves; scales in both sexes persistent, obovate, very obtuse, 1–1.2 mm long, dark brown or blackish, densely clothed with long straight or tangled hairs; capsules lanceolate, 3.5–4.5 mm long, greenish, glabrous; pedicels 0.5–1 or 1.5 mm long, glabrous; styles 0.4–0.8 mm. long, entire of more or less bifid; stigmas shorter, usually notched.

This southern variety of *S. lasiolepis* is named for Mrs. H. P. Bracelin, of Berkeley, Calif., in recognition of her extensive and discriminating collecting, and her careful and informative labeling, of California willows over a period of years. The material thus made available has added greatly to our knowledge of the characteristics, habitats, and distribution of the numerous species and varieties in that State.

The narrow-leaved arroyo willow is a shrub or small tree, occurring mostly along mountain streams at middle altitudes from southern California and northern Baja California eastward in southern parts of Nevada and Utah, most of Arizona and New Mexico, southwestern Texas, and northern Sonora and Chihuahua in Mexico. In California, it ranges from 2,500 or 3,000 feet to 6,000 and sometimes 7,200 feet in altitude. In the other States it occurs mostly from 5,000 to 7,500 or 8,000 feet. It flowers in January and February southward and at lower altitudes and in March and April northward and at higher altitudes.

The center of distribution for *S. lasiolepis* is in the southern two-thirds of California, where the species and all its four varieties are found. Their total distribution area is shaped like a boot facing east, the foot to the south and the top to the north. The heel (Baja California) and sole (Sonora, Chihuahua) are in Mexico. The foot extends from the southern half of California and adjacent Nevada and Southern Utah across Arizona and New Mexico, with the toe in southwestern Texas. The top extends northwards from northern California and Nevada into Washington and Idaho.

There is progressive widening of the leaves from south to north in this total area. Variety *bracelinae*, with rather linear leaves, occupies the foot of the boot. *S. lasiolepis*, with oblanceolate leaves, ranges from the heel in Baja California northward to Washington and Idaho. Variety *bakeri*, of the Bay Area, does not differ in leaf shape. Variety *bigelovii*, with obovate leaves, is found mostly near the coast, and variety *sandbergii*, with elliptic-oval or obovate-oval leaves, is found in northern California and Idaho. A fifth variety, *fallax* Bebb, if recognized, has elliptical leaves and is found in the Sierra Nevada. The species not only has broader leaves than variety *bracelinae* but the twigs usually darken more rapidly and more completely. In southern California and adjacent Nevada, the species is about as common and widely distributed as is variety *bracelinae* and also occurs sparingly in northern Arizona.

Because the center of distribution for the species and its varieties is near the coast in central California, distribution is indicated here from north and west to south and east. Authenticated specimens of variety *bracelinae* are cited, for States and Counties, by collector, number, and year. Where there is no collection number, fuller data are given. Citation of Mexican specimens follows that of United States specimens. Containing herbariums are indicated as follows: Carleton R. Ball (CRB); U. S. Forest Service (FS); N. Y. State Museum (NYSM); Omer E. Sperry (OES); Pomona College (PC); Southern Methodist University (SMU); Texas A. and M. College (TAC); Texas State University (TSU); and U. S. National Herbarium (USN).

California, Central. Sonoma County: Bodega Bay, *W. A. Setchell 19*, on 1931 (CRB); Russian River between Monte Rio and Duncan's Mills, *Setchell 22*, in 1931 (CRB). Yuba County: Horse Hop Ranch, Wheatland, *Carleton R. Ball 1718*, in 1911 (CRB, USN). Contra Costa County: Antioch, *Alice Eastwood 3726*, *3727*, *3728*, *3729*, in February 1914 (USN, *3728* stam. type; *3729* pist. type; both with persistent leaves of 1913). Alpine County; Markleeville, Diamond Ranch, alt. 5,500 feet, *H. Lee 107*, in 1934 (CRB). Madera County: Northfork, E. G. Dudley, November 1911 (CRB). Fresno County: Millwood, *J. D. Culbertson 4665*, in 1904 (USN). Monterey County: Between Jelon and Memorial Park, *Milo S. Baker 7932*, in 1934 (CRB). Tulare County: Near Visalia, *F. V. Coville & Frederick Funston 268*, in 1891 (USN, vigorous shoot with large leaves). Inyo County (all from Panamint Mountains): *Coville & Funston 493*, *597*, *625*, in 1891 (USN); *Coville & M. French Gilman 221*, *222*, alt. 7,300 feet, in 1931 (USN); *Gilman 2134*, *2138*, *2156*, *2232*, in 1936 (USN); Willow Springs, 14 miles east of Independence, *Mark Kerr 71*, in 1932 (CRB); some others are too juvenile for certain determination.

California, Southern. Kern County: Edge of desert, 1 mile east of Walker Pass Summit, alt. 5,250 feet, *Mrs. H. P. Bracelin, Carl Skottsberg, & J. T. Howell 2870*, *2871*, in 1948 (CRB, some old leaves persisting); Tejon Mountains, *F. R. Fosberg 7054* (CRB, USN), *7055*, (CRB), *7056* (CRB, 5 sheets; USN), all in 1931; Johnson Canyon, Walker Basin, *Fordyce Grinnell 61*, in 1905 (USN); Mount Pinos, San Emigdio Poturos, *H. M. Hall 6390*, in 1905 (CRB). Ventura County: Topa Topa Mountains, *L. R. Abrams & E. A. McGregor 105*, in 1908 (USN); Mount Pinos region, *W. R. Dudley & F. H. Lamb 4616*, in 1896 (USN); same, *C. Epling & L. C. Wheeler 1831*, in 1933 (CRB); same, Ralph Hoffmann, on June 5, 1930 (CRB): Mount Pinos, *Carl W. Sharsmith 1*, on October 25, 1931 (CRB). Los Angeles County: Inglewood, *Abrams 3103*, in 1902 (USN); *Bracelin & Fosberg 572*, in 1931 (CRB); Sierra Santa Monica, *W. H. Brewer 86*, *87*, *88*, on December 23, 1860 (USN, new aments, old leaves persisting); same, *Fosberg 5852*, in 1931 (CRB); same, *Fosberg 7172* (USN), *7173*, *7176* (USN), *7177* (USN), *7178* (USN), *7179*, all January 26, 1932 (all CRB); same, *Fosberg 7410*, *7412*, *7414*, *7415*, all March 3, 1932 (CRB); same, Walter M. Moode, on October 6, 1912 (CRB); San Gabriel Mountains, *George L. Moxley 1038*, in 1921 (USN); same, Ojai, S. F. Peckham, on February 4, 1866 (USN); same, *F. W. Peirson 4281*, in 1919, *9767* in 1932 (both CRB); same, *Sharsmith 3*, *4*, in 1931 (CRB); San Gabriel Canyon, *Sharsmith 6*, *7* (USN), *7a*, *9* (USN) *10*, all in 1932 (all CRB, with some persisting leaves of 1931); same, *Wheeler 1467*, *1472*, in 1933 (CRB). Orange County: Temiscal Range, *Brewer 154*, in January 1861 (USN). San Diego County: Pine Valley Creek bridge, 9.5 km east of Descanso, alt. 1,020 meters, *Bracelin 618*, *619*, in 1932 (CRB, USN); San Diego, J. G. Cooper, in 1860–67 (USN); same, *Carl V. Meyer 828*, on December 26, 1931 (CRB, old leaves persisting); Camp Kearney, *Harold E. Parks 0332a*, in 1929 (USN); same, *Parks & Susan T. Parks*, *01091a*, *b*; *01092a*, *b* (b in USN); *01093a*, *b*, all January 17, 1932 (all CRB, all stam. spec. (a), and one pist. spec. (b), with old leaves persisting); some other collections by Bracelin and by Meyer are too juvenile for certain determination as variety.

California, Southeastern. San Bernardino County (practically all from San Bernardino Mountains): Cajon Pass, *Coville & Funston 129*, in 1891 (USN); south fork of Santa Ana River, alt. 6,200 feet, *J. & H. W. Grinnell 356*, in 1906 (USN); San Bernardino, *J. B. Leiberg 3242*, in 1898 (USN); same, C. D. Mell, on February 10, 1904 (CRB); same, *P. A. Munz 12664*, *12709*, in 1932 (CRB); same, *S. B. Parish 3004*, in 1894, *4625*, in 1901 (both USN); same, *Peirson 9972*, in 1932, at 6,900 feet alt. (CRB); same, *George R. Vasey 271, 273*, in January 1881 (USN); same, Vasey, in February 1881 (USN, 1 sheet (pist.) with persisting old leaves; 3 others, including *274*, represent the species). San Bernardino or Riverside Counties (mostly in San Bernardino Mountains): *Munz & Johnston 5241*, in 1922 (CRB); *Munz 5732*, in 1922 (CRB); *Munz 12905*, in 1932, at 7,200 feet alt. (CRB); *S. B. & W. F. Parish 675*, in 1881 (NYSM, USN, new aments and old leaves on December 20). Riverside County: Corona, Richard L.Cosby, on January 11, 1945 (CRB, "good pollen and nectar plant for bees"); Strawberry Valley, W. L. Jepson and Hall, on May 17–June 1, 1901 (NYSM); San Jacinto Mountains, *Munz & Johnston 5518*, in 1922 (CRB); same, *Setchell & Duran 7*, in 1935 (CRB).

Nevada. Nye County: 20 miles northeast of Warm Springs, *K. H. McKnight & Calvin McMillan 38*, in 1942 (CRB). Lander County: Up Skull Creek near Grass Valley Ranch, *F. S. Goodner & W. H. Henning 446*, in 1937 (CRB); Le Madre Mountains, *Ivar Tidestrom 10964*, in 1919 (USN). Clark County: Excelsior Canyon, Charleston Mountains, *I. W. Clokey 8752*, in 1941 (CRB); Toyabe Range, *Clokey 7885*, in 1919 (USN, probably the variety, but other collections there are the species).

Utah. Washington County: 3 miles east of Pine Valley, alt. 7,000 feet, *Frank W. Gould 1781*, in 1942 (CRB). Iron County: Parawan, alt. 1,800–2,000 meters, *W. W. Eggleston 14903*, in 1918 (USN). All other Utah specimens seen are of the species.

Arizona. Coconino County (all from Flagstaff): *Chester F. Deaver 44*, in 1941 (CRB); Mount Eden, alt. 7,500 feet, *E. A. Goldman 2059*, in 1913 (USN) Yavapai County (all Prescott): Elmer D. Ball, in August–September 1932 (CRB); E. W. Gifford, on June 12, 1932 (CRB); *Peebles, Harrison, & Kearney 2618*, in 1926 (USN). Apache and Navajo Counties (southern parts, and perhaps adjacent parts of Coconino and Gila Counties also, mostly in the White Mountains Indian Reservation and Black Mesa Forest Reserve): *Coville 1008, 1018, 1056, 1064, 1077, 1085, 1094*, in 1900 (all USN); *Coville 1912* (probably Gila County), *2023*, in 1904 (USN). Gila County: *Bassett Maguire 10054*, in 1930 (CRB); the species is represented by Walter Hough 92, from Gila County in 1901 (USN). Graham County: *E. G. H. 118*, on May 20, 1914 (CRB, as *S. irrorata*); *H. H. Rusby 372*, in February 1881 (USN, 2 sheets). Pima County (Santa Catalina Mountains): *David Griffiths 7037*, in 1904 (CRB); *J. Arthur Harris C16437*, in 1916 (USN); alt. 7,500 feet, *R. H. Peebles 4072*, in 1927 (USN); same alt., *Peebles & H. F. Loomis 7105*, in 1930 (USN); alt. 7,900 feet, *R. D. Roseberry 79*, in 1937 (CRB); J. J. Thornber, on February 15, 1904 (USN): *Tidestrom 12560*, in 1927 (CRB); *George R. Vasey 8* (number in pencil), in March 1881 (USN). Pima or Santa Cruz County (Santa Rita Forest Reserve): *Griffiths 4198*, in 1903 (CRB, USN). Cochise County (Chiricahua Mountains): Dan Axelrod, on May 7, 1941 (CRB); *J. C. Blumer 2281, 2282, 2283, 2303*, in 1906 (CRB); *W. W. Eggleston 11011*, in 1914 (USN); *J. W. Toumey 183*, in 1894 (CRB); Toumey, in March and July 1894 (USN); Toumey, on May 1, 1897 (USN). Cochise County (Huachuca Mountains): *L. N. Goodding 372, 914, 1040*, in 1949 (CRB); *Kearney & Peebles 13846*, in 1937 (USN); *E. A. Mearns 2176, 2614*, in 1893 (USN); *T. E. Wilcox 81, 84*, in 1894 (USN). County unknown: Beaver Creek, B. E. Fernow, in August 1896 (USN).

New Mexico. Catron County: Beaverhead Ranger Station, *Goodding 30, 31*, on May 20, 1938 (CRB, twigs somewhat pruinose): Reserve, *Goodding A 9633*, in 1939 (CRB). Colfax County: *Goodding A 9645*, in 1939 (CRB). Dona Ana County (all Organ Mountains, by E. O. Wooton): Filmore Canyon, alt. 5,500 feet, on February 10, March 12 (3 sheets), and April 15 (2 sheets), in 1899 (USN); same, alt. 7,000 feet, on April 15, 1899 (USN); same, alt. 7,000 feet, on April 18, 1903 (USN, 2 sheets); Organ Peak, alt. 8,000 feet, on April 18, 1903 (USN).

Texas (several specimens with twigs faintly pruinose). Brewster County: Infrequent at Buena Vista, *B. H. Warnock 123*, in 1937 (USN). Culberson County (Guadalupe Mountains): *Paul C. Standley 40485*, in 1924 (USN); M. S. Young, on August 29, 1916 (TSU). Jeff Davis County (Davis Mountains): *Vernon Bailey 407*, in 1901 (USN); *D. C. Correll 13548, 14064*, in 1946 (SMU); *V. L. Cory 53086* (USN), *53106, 53158*, in 1946 (all SMU); *L. C. Hinckley 1095*, in 1935 (CRB, TSU); *C. L. & Amelia A. Lundell 14251*, in 1945 (CRB, SMU); *C. H. Muller 8184*, in 1945 (SMU); *E. J. Palmer 30799, 32008, 32157*, in 1926 (CRB, TSU, USN); *Palmer 33431, 34479*, in 1928 (USN); *H. B. Parks & V. L. Cory 9098*, in 1934 (CRB, TAC); *Parks & Cory 18520, 18521*, in 1936 (TAC); *Omer E. Sperry T 2*, on May 3, 1936 (OES, USN). Presidio County: Sierra Tierra Vieja, *Hinckley 2726, 2727*, in 1943 (CRB); Chinata Mountains, *Hinckley & Warnock 46900*, in 1946 (CRB). County unknown: Valery Havard, in October 1883 (USN).

Mexico. Baja California: Hamilton Ranch, Marcus E. Jones, on April 15, 1925 (USN); San Vicente and vicinity, Jones, on December 16, 1927 (PC, as *S. laevigata*); Nachoguero Valley, *L. Schoenfeldt 3436*, in 1894 (USN); 2 miles south of Santa Tomás, alt. 585 feet, *Ira L. Wiggins 4271*, in 1930 (USN); La Encinal, on west side of Sierra San Pedro Mártir, alt. 6,000 feet, *Wiggins 9798*, in 1941 (USN). Sonora (region of Río de Bavispe): Jarilla, Cañon de Bavispe, *Stephen S. White 3312*, in 1940 (CRB); Las Tierritas de El Temblor, Sierra de El Tigre, *White 3397*, in 1940 (CRB); Rancho del Robles, northeast of El Tigre, alt. 6,000 feet, *White 4276*, in 1941 (CRB). Chihuahua: Sierra Madre Mountains, alt. 7,000 feet, Jones, on September 19, 1903 (PC); Mojarichic, *Irving Knobloch 5849*, in 1939 (   ); same, *Knobloch 7052*, in 1940 (   ); Majalca, *Harde Le Seuer 593*, in 1936 (SMU); valley near Chihuahua, *C. G. Pringle 709*, in 1886 (USN, 3 sheets). Coahuila: San Lorenzo Canyon, mountains near Saltillo, alt. 7,000 feet, *Pringle 10210*, in 1906 (USN).

ZOOLOGY.—*The feather-stars, sea-urchins, and sea-stars of the United States Navy Antarctic Expedition 1947–48.* Austin H. Clark, U. S. National Museum.[1]

While accompanying the United States Navy Antarctic Expedition 1947–48 Comdr. David C. Nutt, USNR, assembled a large and representative collection of echinoderms. Most of the specimens are from Marguerite Bay and the immediate vicinity of the Palmer Peninsula, but a few are from as far east as Knox Land.

Although there are no new species of Crinoidea, Echinoidea, or Asteroidea, the additional records are of much interest.

CRINOIDEA

Antedonidae

Heliometrinae

Promachocrinus kerguelensis P. H. Carpenter

Promachocrinus kerguelensis P. H. Carpenter, Proc. Roy. Soc. **28**: 385. 1879; *Challenger* Reports, Zoology, **26** (pt. 60): 350, pl. 1, figs. 1, *a–d*, pl. 70. 1888.

Localities.—Marguerite Bay; 35 fathoms; water temperature 30° F.; February 20, 1948 (11 specimens, U.S.N.M. no. E.7975).

Marguerite Bay; 40 fathoms; water temperature 30° F.; February 22, 1948 (7 specimens, U.S.N.M. nos. E.7976, E.7978).

Off Knox coast (lat 66° 31′ S., long. 110° 26′ E.); 100 fathoms; January 19, 1948 (1 specimen, U.S.N.M. no. E.7974).

Notes.—The specimens from Marguerite Bay in 35 fathoms all have 10 rays and 20 arms from 35 to 150 mm long; most of them are small. The specimens from Marguerite Bay in 40 fathoms all have 10 rays and 20 arms, in the largest 160 mm in length; all are large. The specimen from the Knox coast has 6 rays and 12 arms 150 mm long; the cirri are 50 mm long.

Florometra mawsoni A. H. Clark

Florometra mawsoni A. H. Clark, Australasian Antarctic Exped. 1911–14, Sci. Rep., ser. C, Zool. and Bot., **8** (4): 10. 1937.—John, *Discovery* Reports **18**: 144, pl. 3, fig. 2. 1938.

Locality.—Lat. 65° 25′ S., long. 101° 13′ E.; 100 fathoms; water temperature 30° F.; January 14, 1948 (1 specimen, U.S.N.M. no. E.7973).

ECHINOIDEA

Echinidae

Sterechinus antarcticus Koehler

Sterechinus antarcticus Koehler, Resultats du voyage du S. Y. *Belgica* en 1897–1898–1899; Rapports scientifiques, Zoologie: Échinides et ophiures: 8, pl. 2, figs. 9, 10, pl. 3, fig. 18, pl. 8, figs. 55, 56. 1901.

Localities.—Off Cape Royds, Ross Island; 58 fathoms; January 29, 1948 (3 specimens, U.S.N.M. no. E.7653).

Marguerite Bay; 115 fathoms; water temperature 30.2° F.; February 18, 1948 (2 very small specimens, U.S.N.M. no. E.7652).

Marguerite Bay; 35–105 fathoms; water

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temperature 30.2° F.; February 19, 1948 (16 specimens, U.S.N.M. nos. E.7649, E.7650).

Marguerite Bay; 35 fathoms; water temperature 30° F.; February 20, 1948 (3 small specimens, U.S.N.M. no. E.7708).

Island in Marguerite Bay; tide pools; February 21, 1948 (4 specimens, U.S.N.M. no. E.7648).

Marguerite Bay; 40 fathoms; water temperature 30° F.; February 22, 1948 (59 specimens, U.S.N.M. nos. E.7651, E.7655, E.7656).

Notes.—Two of the specimens from tide pools on an island in Marguerite Bay measure, diameter 38 mm, height 23 mm, and diameter 38 mm, height 22 mm.

The specimens from Marguerite Bay in 40 fathoms are up to 30 mm in diameter.

ASTEROIDEA

ASTROPECTINIDAE

Leptychaster magnificus (Koehler)

Priamaster magnificus Koehler, Deuxième Expédition Antarctique Française (1908–1910): Échinodermes (Astéries, Ophiures et Échinides): 92, pl. 8, figs. 1, 3, 8. 1912.

Locality.—Marguerite Bay; 35 fathoms; water temperature 30° F.; February 20, 1948 (2 speciments, U.S.N.M. nos. E.7638, E.7642).

Note.—One of the specimens has R = 150 mm; in the other R = 65 mm, r = 25 mm.

Psilaster charcoti (Koehler)

Ripaster charcoti Koehler, Expédition Antarctique Française (1903–1905), Échinodermes: 4, pl. 3, figs. 20, 21, 31, 32. 1908.

Localities.—Peter Island; 30 fathoms; water temperature 29.6° F.; February 15, 1948 (4 specimens, U.S.N.M. nos. E.7640, E.7641, E.7677).

Marguerite Bay; 35 fathoms; water temperature 30° F.; February 20, 1948 (2 specimens, U.S.N.M. no. E.7639).

Notes.—Three of the specimens from Peter Island have the following measurements: R = 90 mm, r = 27 mm; R = 85 mm, r = 26 mm; R = 55 mm, r = 14 mm. In the largest the spines on the marginals are strongly developed.

In one of the specimens from Marguerite Bay R = 110 mm, r = 30 mm; the spines on the marginals are strongly developed. In the other R = 100 mm, r = 30 mm; spines are present on the infero-marginals only at the base of the arms; after the basal half of the arms the spines on the superomarginals are represented by a few small ones on the aboral ends of the plates.

ODONTASTERIDAE

Odontaster meridionalis (E. A. Smith)

Astrogonium meridionale E. A. Smith, Ann. Mag. Nat. Hist. (ser. 4) **17**: 109. 1876.

Locality.—Marguerite Bay; 35 fathoms; water temperature 30° F.; February 20, 1948 (1 speciment, U.S.N.M. no. E.7645).

Note.—In this specimen R = 18 mm, r = 10 mm.

Odontaster validus Koehler

Odontaster validus Koehler, Expédition Antarctique Française (1903–1905), Échinodermes: 6, pl. 3, figs. 22–26. 1906.

Localities.—Off Cape Royds, Ross Island; 58 fathoms; January 29, 1948 (32 specimens, U.S.N.M. nos. E.7643, E.7686).

Near Cape Royds; caught along the beach; January 29, 1948 (2 specimens, U.S.N.M, no. E.7644).

Marguerite Bay; 115 fathoms; water temperature 30.2° F.; February 18, 1948 (1 specimen, U.S.N.M. no. E.7654).

Marguerite Bay; 35 fathoms; water temperature 30° F.; February 20, 1948 (1 specimen U.S.N.M. no. E.7641).

Marguerite Bay; 40 fathoms; water temperature 30° F.; February 22, 1948 (7 specimens, U.S.N.M. no. E.7647).

Notes.—The specimens from off Cape Royds in 58 fathoms range in size from R = 35 mm to R = 6 mm. One of the smallest, with R = 6 mm, is 4-rayed. The largest has R = 35 mm, r = 13 mm.

The two specimens from the beach near Cape Royds measure R = 40 mm, r = 16 mm, and R = 33 mm, r = 18 mm.

The specimens from Marguerite Bay in 40 fathoms range from R = 32 mm to R = 12 mm.

Acodontaster elongatus (Sladen)

Gnathaster elongatus Sladen, *Challenger* Reports, Zoology, **30** (pt. 51): 288, pl. 48, figs. 1–4, pl. 49, figs. 5–10, pl. 19, figs. 5, 6. 1889.

Odontaster capitatus Koehler, Deuxième Expédition Antarctique Française (1908–1910), Échinodermes (Astéries, Ophiures et Échinides): 82, pl. 6, figs. 5, 8, 9, 11. 1912.

Localities.—Marguerite Bay; 35 fathoms; water temperature 30° F.; February 20, 1948 (2 specimens, U.S.N.M. nos. E.7636, E.7694).

Island in Marguerite Bay; from tide pools along shore; February 21, 1948 (1 specimen, U.S.N.M. no. E.7637).

Notes.—In one of the specimens from Marguerite Bay in 35 fathoms (E.7636) R = 27 mm, r = 9 mm. The outer half of the rays is very slender. On the oral side in each interradius, about as far from the recurved tooth as the latter's length, there is a large 4-bladed pedicellaria surrounded by a bare space. In the other specimen R = 22 mm, r = 7 mm.

In the specimen from an island in Marguerite Bay R = 30 mm, r = 10 mm. There is only a single pedicellaria present which is not easily distinguishable from the surrounding spines.

All these specimens represent the form *capitatus* Koehler, originally described from a single specimen from Marguerite Bay.

GANERIIDAE

Perknaster aurantiacus Koehler

Perknaster aurantiacus Koehler, Deuxième Expédition Antarctique Française (1908–1910), Échinodermes (Astéries, Ophiures et Échinides): 36, pl. 3, fig. 9, pl. 4, fig. 1. 1912.

Locality.—Marguerite Bay; 35 fathoms; water temperature 30° F.; February 20, 1948 (2 specimens, U.S.N.M. no. E.7695).

Note.—The two specimens measure R = 45 mm, r = 13 mm, and R = 20 mm, r = 6 mm.

SOLASTERIDAE

Cuenotaster involutus (Koehler)

Leucaster involutus Koehler, Deuxième Expédition Antarctique Française (1908–1910), Échinodermes (Astéries, Ophiures et Échinides): 55, pl. 5, figs. 1, 2, 3, 6, 7, 10, 11. 1912.

Locality.—Marguerite Bay; 40 fathoms; water temperature 30° F.; February 22, 1948 (1 specimen, U.S.N.M. no. E.7703).

Note.—The specimen measures R = 35 mm, r = 10 mm.

KORETHRASTERIDAE

Remaster gourdoni Koehler

Remaster gourdoni Koehler, Deuxième Expédition Antarctique Française (1908–1910), Échinodermes (Astéries, Ophiures et Échinides): 60, pl. 5, figs. 4, 5, 9, 12, pl. 8, fig. 7. 1912.

Locality.—Marguerite Bay; 35 fathoms; February 20, 1948 (3 specimens, U.S.N.M. no. E.7635).

Note.—In these specimens R varies from 7 to 9 mm.

ASTERIIDAE

Labidiaster annulatus Sladen

Labidiaster annulatus Sladen, *Challenger* Reports, Zoology, **30** (pt. 51): 595, pl. 108, fig. 1. 1889.

Locality.—Marguerite Bay; February 22, 1948 (1 specimen, U.S.N.M. no. E.7657).

Note.—This specimen has 36 arms 160 mm long; the disk is 50 mm in diameter.

Lysasterias perrieri (Studer)

Anasterias perrieri Studer, Jahrb. wiss. Anst. Hamburg **2**: 153. 1885.

Localities.—Off Knox coast, Antarctica (lat. 66° 31′ S., long. 111° 26′ E.); 100 fathoms; January 19, 1948 (1 specimen, U.S.N.M. no. E.7699).

Island in Marguerite Bay, from tide pools along the shore; February 21, 1948 (1 specimen, U.S.N.M. no. E.7700).

Marguerite Bay; 40 fathoms; water temperature 30° F.; February 22, 1948 (1 specimen, U.S.N.M. no. E.7701).

Notes.—In the specimen from the island in Marguerite Bay R = 50 mm, r = 10 mm. In the specimen from Marguerite Bay in 40 fathoms R = 30 mm, r = 5 mm.

Lysasterias joffrei (Koehler)

Paedasterias joffrei Koehler, Australasian Antarctic Expedition 1911–14, Scientific Reports, Series C, Zoology and Botany **8** (pt. 1), Echinodermata Asteroidea: 30, pl. 1, figs. 3, 4, 9, pl. 2, figs. 7, 8, 9, pl. 56, fig. 2. 1920.

Locality.—Island in Marguerite Bay, from tide pools along the shore: February 21, 1948 (1 specimen, U.S.N.M. no. E.7702).

Note.—In this specimen R = 90 mm, r = 15 mm.

Adelasterias papillosa (Koehler)

Diploasterias papillosa Koehler, Expédition Antarctique Française (1903–1905): 21, pl. 1, figs. 2–5, pl. 2, figs. 18, 19. 1906.

Localities.—Marguerite Bay; 35 fathoms; water temperature 30° F.; February 20, 1948 (1 specimen, U.S.N.M. no. E.7696).

Island in Marguerite Bay, from tide pools along the shore; February 21, 1948 (1 specimen, U.S.N.M. no. E.7697).

Note.—The specimens measure R = 15–16 mm, r = 4 mm.

MALACOLOGY.—*Recent species of the prionodont pelecypod* Cucullaea[1]. DAVID NICOL, U. S. National Museum.

A review of the living species of *Cucullaea* has not been made since Lamy (1907, pp. 306, 307) made one more than 40 years ago, although Iredale (1939, pp. 250–252) thoroughly reviewed the species names.

This study is the second of a series on relict marine bivalve families, and its scope is the same as that made on the fimbriids. The cucullaeids, like the fimbriids, have a history dating back to the early Jurassic. During Jurassic and Cretaceous times the cucullaeids were abundant in number of species and world-wide in distribution. Rapid decline became apparent after the early Eocene, and the family has since been much restricted in its distribution and number of species. Today the group is found in the Indian Ocean and the western part of the Pacific Ocean. From this brief history of the cucullaeids, it is interesting to note the amazing parallelism with the fimbriids. In minor details there are differences, and the two groups do not quite occupy the same ranges today; but the over-all picture is much alike for both families. Ecologic factors do not enter into this parallelism if we consider the evidence on the basis of the living species.

Genus **Cucullaea** Lamarck, 1801

Genotype.—*Cucullaea auriculifera* Lamarck, 1801 = *Arca cucullata* Röding, 1798 = *Arca cucullus* Gmelin, 1791 = *Arca labiata* Solander, 1786. Subsequent designation, J. G. Children, 1823, p. 318.

Winckworth (1944, p. 231) listed two earlier genotype designations for *Cucullaea*, but neither of these is valid. Schmidt (1818, p. 65) designated *Arca cucullus* Gmelin as the genotype, but this species name was not included in Lamarck's original description, nor can *Arca cucullus* Gmelin be considered as an objective synonym of *Arca cucullata* of Chemnitz. Fleming (1818, p. 306) made the following statement concerning *Cucullaea*: "In the genus *Cucullaea*, the teeth of the hinge are similar to the Arcae, but at each extremity there are three or four transverse parallel ribs. It is represented by the *Arca cucullata* of Chemnitz. Conch. VII, p. 174. tab. 55, f. 526–528." This cannot be construed as a genotype designation, and, furthermore, it is certainly not clear that Fleming was referring to types in the modern sense.

Cucullaea labiata (Solander)

Figs. 1–8

1786. *Arca labiata* Solander, Catalogue Portland Museum: 185, lot 3947.
1789. *Arca concamera* Bruguière, Encyclopédie méthodique, histoire naturelle des vers, texte 1 (aber-con): 102, 103.
1791. *Arca cucullus* Gmelin, Systema naturae, ed. 13, **1**(6): 3311.
1798. *Arca cucullata* Röding, Museum Boltenianum, pt. **2**: 173, no. 207.
1801. *Cucullaea auriculifera* Lamarck, Système des animaux sans vertèbres: 116.
1835. *Arca concamerata* Deshayes, Histoire naturelle des animaux sans vertèbres, ed. 2, **6**: 454.
1846. *Cucullaea granulosa* Jonas, Proc. Zool. Soc. London, 1846, pt. **14**: 34, 35.
1857. *Cucullaea concamerata* (Deshayes), Deshayes, Traité élémentaire de conchyliologie **2**: 379, 380, pl. 36, figs. 12, 13.
1860. *Cucullaea plicata* Theobald [nomen nudum], Catalogue Recent shells Museum Asiatic Society of Bengal: 126.
1869. *Cucullaea concamerata* (Deshayes), Reeve, Conchologia iconica **17**: Genus *Cucullaea*, species 1, fig. 1.
1869. *Cucullaea granulosa* Jonas, Reeve, Conchologia iconica **17**: Genus *Cucullaea*, species 2, figs. 2a, b.
1869. *Cucullaea auriculifera* Lamarck, Reeve, Conchologia iconica **17**: Genus *Cucullaea*, species 3, fig. 3.
1891. *Cucullaea concamerata* (Deshayes), Kobelt, Systematisches Conchylien-Cabinet von Martini und Chemnitz, Die Gattung *Arca L.*, **8**(2): 5, 6, pl. 1, figs. 3, 4, pl. 5, figs. 1, 2.
1891. *Cucullaea granulosa* Jonas, Kobelt, Systematisches Conchylien-Cabinet von Martini und Chemnitz, Die Gattung *Arca* L., **8** (2): 6, 228, pl. 1, fig. 5.
1907. *Cucullaea concamerata* (Deshayes), Lamy, Journ. Conchyl. **55**(3): 306.
1907. *Cucullaea granulosa* Jonas, Lamy, Journ. Conchyl. **55**(3): 306, 307.
1909. *Arca* (*Cucullaea*) *concamerata* Deshayes, Lynge, Danish expedition to Siam 1899–1900, IV: Marine Lamellibranchiata: 128.
1930. *Cucullaea vaga* Iredale, Rec. Australian Mus. **17**(9): 385.
1939. *Cucullaea labiata petita* Iredale, Great Barrier Reef expedition 1928–29, Scientific Reports, **5**(6): Mollusca pt. 1: 250–252, pl. 2, figs. 1a, 17, 17a, 17b.

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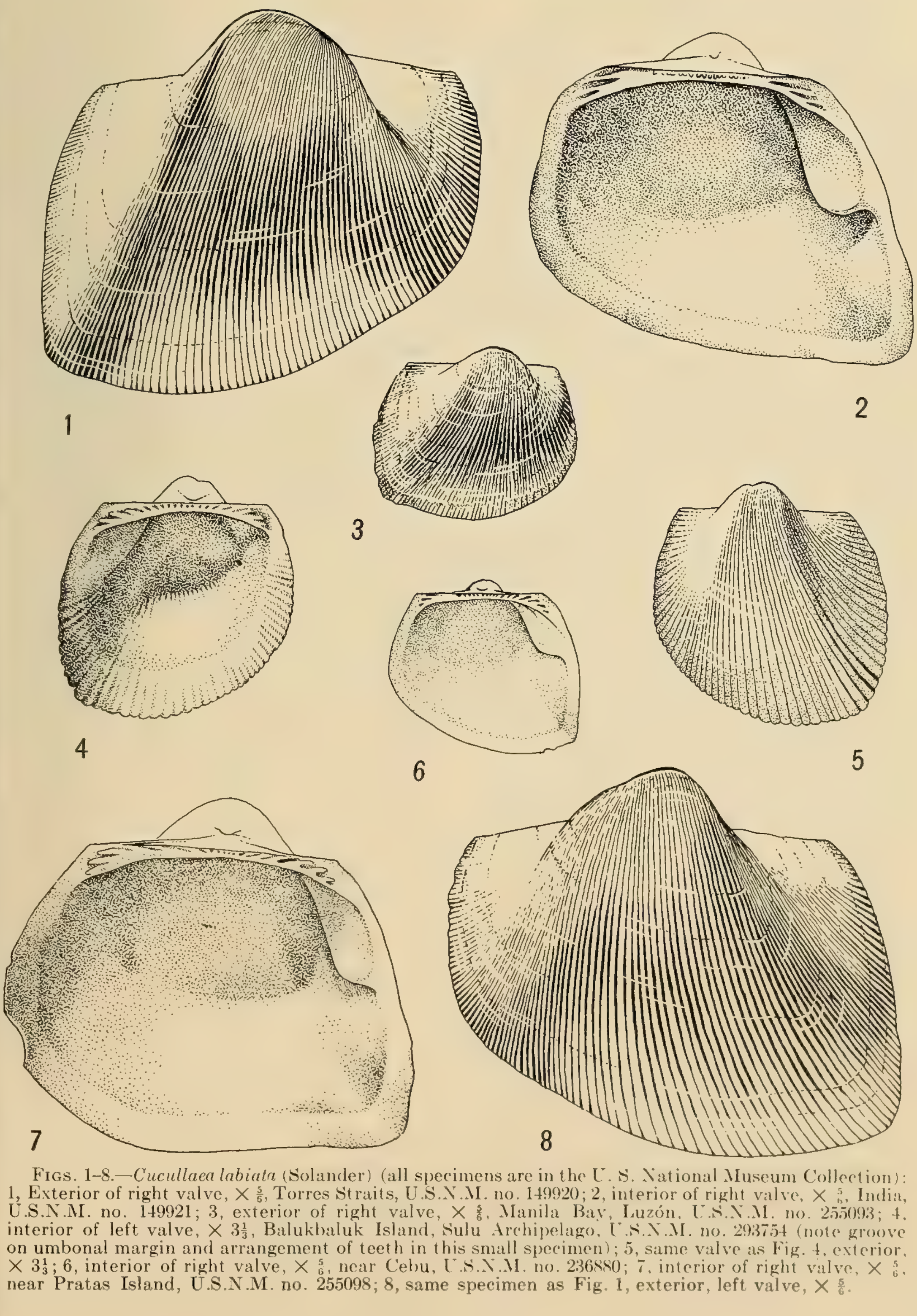

Figs. 1–8.—*Cucullaea labiata* (Solander) (all specimens are in the U. S. National Museum Collection): 1, Exterior of right valve, × $\frac{5}{6}$, Torres Straits, U.S.N.M. no. 149920; 2, interior of right valve, × $\frac{5}{6}$, India, U.S.N.M. no. 149921; 3, exterior of right valve, × $\frac{5}{6}$, Manila Bay, Luzón, U.S.N.M. no. 255093; 4, interior of left valve, × $3\frac{1}{3}$, Balukbaluk Island, Sulu Archipelago, U.S.N.M. no. 293754 (note groove on umbonal margin and arrangement of teeth in this small specimen); 5, same valve as Fig. 4, exterior, × $3\frac{1}{3}$; 6, interior of right valve, × $\frac{5}{6}$, near Cebu, U.S.N.M. no. 236880; 7, interior of right valve, × $\frac{5}{6}$, near Pratas Island, U.S.N.M. no. 255098; 8, same specimen as Fig. 1, exterior, left valve, × $\frac{5}{6}$.

Description.—The shell is porcellaneous and thin, and the thick, velvety periostracum is better developed in cooler water. The valves are unequal, the left valve overlapping the right along the posteroventral and ventral borders. Valve outline can be subquadrate, subtrapezoidal, or subtrigonal, whereas the posterior side is always flattened and more or less truncated. The valves are subequilateral and do not gape. In young shells the radial ribs are raised and tend to split, and new ribs form in the interspaces. The radial ribs are usually broader than the interspaces. There are concentric raised threads at regular intervals. In mature specimens the radial ribs tend to flatten and widen; less splitting occurs. Concentric threads give the ornamentation a cancellate appearance. On some specimens the radial ribs are broader and flatter on the left valve. The variation in ornamentation is great. On large shells the crenulations on the interior ventral border are small and numerous. On small shells these crenulations are better marked and are also seen on the anteroventral and posteroventral margins. In the smallest specimens these crenulations are strongly marked, and the ribs are reflected on the interior of the shell. The beaks are orthogyrate. In young specimens the umbonal area shows a groove located slightly anterior to the center, but it is difficult to see on large shells. This shallow groove is not confined to the cucullaeids but is well developed in many other prionodonts and may have systematic importance. The ligament is external and amphidetic, although slightly more of the ligament lies anterior to the beaks than posterior to them. The ligamental area is flat and shallow. The ligament shows only fine lines running parallel to its long axis, and the loss of well-developed ligamental chevrons is a late development among the cucullaeids. In small shells the teeth are nearly all the same size and look much like the teeth of *Anadara* and *Glycymeris*. The larger specimens show a reduction in the height of the central part of the hinge plate, and a corresponding reduction in the size of the central teeth makes them look like the blade of a saw. The side teeth become reduced in number to about three or four on each end, become elongate, and are arranged nearly parallel to the ligament. The reduction in the height of the hinge plate is another late development in the cucullaeids. The number of teeth is variable, but on small shells there are about 17, whereas on large ones there may be as many as 30. On some intermediate-sized specimens a few of the teeth are hooked or even chevron-shaped. The posterior side of the hinge plate extends ventrally a little farther than the anterior side, and often there is one more posterior side tooth. On large shells the anterior part of the posterior adductor muscle lies on a built-out flange of shell material; this is not seen in small shells. The posterior side of the cucullaeid is so truncated that in order for the adductor muscle to exert a force to close the valves, the flange appears to be a mechanical necessity. The anterior adductor muscle scar has only a trace of the flange, but the anterior side is not nearly so truncated. The pallial line is integripalliate, with a slight indentation where it joins the ventral part of the flange of the posterior adductor muscle scar. Color variation is considerable among the cucullaeids. Specimens from southern Japanese waters are often deep purple interiorly. One specimen from India is light purple along the posterior margin of the interior of the shell and has a brown and purple streak at the base of the flange for the posterior adductor muscle. Shells from the Philippines are light brown to orange exteriorly. According to Dr. Joyce Allan (personal communication), specimens of *Cucullaea* from northern Queensland waters are splashed with yellow-orange, and those from the cooler waters of New South Wales have darker colors.

Measurements.—Maximum length was measured rather than the length from the middle of the anterior and posterior ends. Height was measured on the basis of the left, or larger, valve. Only specimens with both valves were measured. Measurements, in millimeters, are as follows:

U. S. N. M. no.	*Length*	*Height*	*Convexity (both valves)*
346134A	99.6	78.4	73.4
149920	90.4	72.4	65.8
273673	81.6	67.0	57.9
249497	78.8	65.5	58.2
149921	77.5	63.0	53.7
273673A	77.4	62.9	52.5
346134	71.5	61.4	53.3
236880	38.5	33.3	26.0

Remarks.—There are 110 specimens of Recent cucullaeids in the U. S. National Museum collection. Most of them are small shells dredged by the *Albatross*.

Locality data.—Specimens from the following localities are in the U. S. National Museum collection:

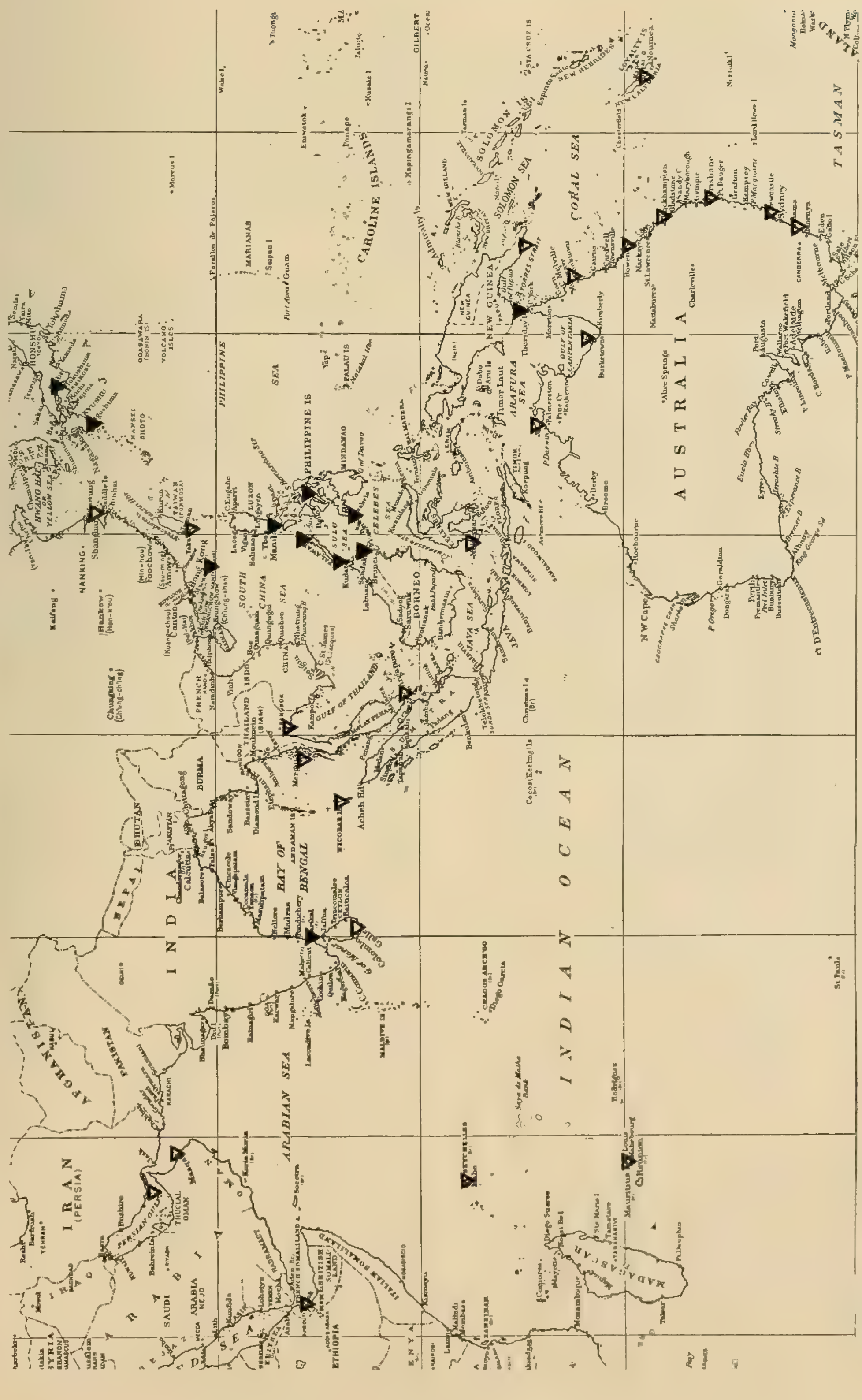

FIG. 9.—Distribution of living specimens of *Cucullaea labiata* (Solander): ▼, Locality data based on U. S. National Museum specimens; ▽, locality data based on specimens in other museums and on published records.

ALBATROSS DREDGING STATIONS

D.5134—Sulu Archipelago near Basilan Island, Balukbaluk Island (N.), S. 59° W., 6.25 miles (6° 44′ 45″ N., 121° 48′ E.). 25 fathoms (45 meters), fine sand.

D.5146—Sulu Archipelago, vicinity of Siasi, Sulade Island (E.), N. 18° W., 3.40 miles (5° 46′ 40″ N., 120° 48′ 50″ E.). 24 fathoms (43 meters), coral sand, shells.

D.5161—Sulu Archipelago, Tawi Tawi Group, Tinakta Island (E.), N. 12° W., 1.80 miles (5° 10′ 15″ N., 119° 53′ E.). 16 fathoms (29 meters), fine sand with black specks.

D.5164—Sulu Archipelago, Tawi Tawi Group, Observation Island, S. 82° W., 8 miles (5° 01′ 40″ N., 119° 52′ 20″ E.). 18 fathoms (33 meters), green mud.

D.5181—Off eastern Panay, Antonia Island (S.), S. 63° W., 6.60 miles (11° 36′ 40″ N., 123° 26′ 35″ E.). 26 fathoms (47 meters), mud and fine sand.

D.5192—Off northern Cebu Island, Jilantaguan Island (E.), N. 13° W., 3 miles (11° 09′ 15″ N., 123° 50′ E.). 32 fathoms (58 meters), green sand.

D.5213—East of Masbate Island, Destacado Island (S.), N. 87° E., 8.50 miles (12° 15′ N., 123° 57′ 30″ E.). 80 fathoms (146 meters), sand, mud, shells.

D.5220—Between Marinduque and Luzon, San Andreas Island (W.), S. 57° W., 8.50 miles (13° 38′ N., 121° 58′ E.). 50 fathoms (91 meters), soft green mud.

D.5310—China Sea, vicinity of Hong Kong, off Pratas Island (21° 33′ N., 116° 13′ E.). 100 fathoms (183 meters), sand, shells, bottom temperature 65.5° F (18.6° C).

D.5311—China Sea, vicinity of Hong Kong, off Pratas Island (21° 33′ N., 116° 15′ E.). 88 fathoms (158 meters), coarse sand, shells.

D.5312—China Sea, vicinity of Hong Kong, off Pratas Island (21° 30′ N., 116° 32′ E.). 140 fathoms (252 meters), sand, small shells, bottom temperature 57.5° F (14.2° C).

D.5314—China Sea, vicinity of Hong Kong, off Pratas Island (21° 41′ N., 116° 46′ E.). 122 fathoms (220 meters), sand, broken shells, bottom temperature 59.5° F (15.3° C).

D.5336—Linapacan Strait off Observatory Island (N.), S. 42° W., 9 miles (11° 37′ 45″ N., 119° 46′ E.). 46 fathoms (83 meters), sand, mud.

D.5342—Malampaya Sound, Palawan Island, Endeavor Point (S.), S. 58° E., 0.5 miles (10° 56′ 55″ N., 119° 17′ 24″ E.). 14–25 fathoms (25–45 meters), gray mud.

D.5357—North Balabac Strait, Balabac Light, S. 65° W., 14.3 miles (8° 06′ N., 117′ 17′ 10″ E.). 68 fathoms (122 meters), coral, sand.

D.5358—Jolo Sea, Sandakan Light (Borneo), S. 34° W., 19.7 miles (6° 06′ 40″ N., 118° 18′ 15″ E.). 39 fathoms (70 meters), mud.

D.5360—Manila Bay, Corregidor Light, N. 74° W., 6.9 miles (14° 21′ N., 120° 41′ E.). 12 fathoms (22 meters), hard bottom.

D.5426—Eastern Palawan and vicinity, 30th of June Island, N. 29° E., 12.2 miles (9° 12′ N., 118° 28′ E.). 27 fathoms (49 meters), fine gray sand.

D.5593—Sibuko Bay, Borneo and vicinity, Mount Putri (sea tangent), N. 52° W., 17.2 miles (4° 02′ 40″ N., 118° 11′ 20″ E.). 38 fathoms (68 meters), fine sand.

Additional localities represented are: India, Japan (Awaji, Boshu? [Boshiu?, Boshin?],Kagoshima Strait, Kyushu), and Torres Straits. The map accompanying this paper (Fig. 9) will give more complete locality data on the living cucullaeids.

THE SPECIES PROBLEM IN LIVING CUCULLAEA

In the past, inadequate descriptions, figures, and locality data on living cucullaeids have caused much confusion concerning the number of species and their true identity. Most conchologists have believed that there were two living species, but a few have maintained that there were three, and still fewer have claimed that there was only one.

If specimens are examined from several localities, the bewildering array of variation becomes apparent at once. Specimens from southern Japan resemble those from New South Wales, but they are not identical with them. Cucullaeids collected in cooler waters seem to have flatter ribs, more periostracum, darker color, and a more subquadrate outline. Ornamentation varies on the two valves of the same shell, and this feature is more pronounced on some specimens than on others. Ribbing also varies with the amount of corrosion of the shell, the size of the shell, and the particular area on the shell where it is studied. Valve outline and hinge teeth vary from one locality to another. The specimens from southern Japan are subquadrate, and those from India are more subtrigonal in form. If conchologists insist on splitting the living cucullaeids into distinct species, then one species will have to be erected for the New South Wales specimens, another for the Queensland specimens, another for the southern Japanese and China Seas specimens, another for the specimens from India, and so on. I am prone to regard these variations, at most, as subspecies.

ECOLOGY AND DISTRIBUTION OF CUCULLAEA

Most of the ecologic data are taken from the records on the *Albatross* dredging stations. There are, however, a few additional observations scattered through the literature on Indo-Pacific mollusks. As far as I am aware, all data are based on dead specimens. Living cucullaeids prefer fine sand or mud bottoms, and they have not been reported at depths greater than 252 meters. They have been found most commonly at depths ranging from 15 to 150 meters but have been collected in as little as five meters of water. Bottom temperatures were recorded in only three Albatross stations where cucullaeids were found. These temperatures ranged from 14.2° C to 18.6° C; and probably the other stations would, for the most part, have a bottom temperature nearer the higher figure, for they were all at shallower depths than the one from which the lowest temperature was recorded. *Cucullaea* does not appear to be associated with coral reefs and seems to be able to withstand lower temperatures than reef corals. The fact that cucullaeids are not associated with reef corals may explain the gaps in their distribution.

Cucullaea labiata is a variable and wide-ranging species. It has been reported living as far west as the Gulf of Aden and near Djibouti on the African east coast, but it has not been reported further south along the African coast. In the Red Sea it has been reported only as "subfossil." *Cucullaea labiata* occurs in Mauritius but has not been reported from Madagascar, although the molluscan fauna of the latter island has been studied with some degree of completeness. The family ranges eastward and is found in the Persian Gulf, Gulf of Oman, India, Malaya, Siam, the Philippine Islands, and thence north and south to Japan and Australia, respectively. In Australia the known distribution of *Cucullaea* is from Melville Island in Northern Territory eastward and southward along the Queensland coast and into New South Wales as far south as Shoalhaven below Sydney. Chavan (1907, p. 307) reports *Cucullaea* from New Caledonia, but no one else has mentioned it from this region. Continued collecting may show that *Cucullaea* occurs farther west in Australia and also farther south along the east coast of Africa and perhaps in Madagascar.

ACKNOWLEDGMENTS

Dr. Joyce Allan, of the Australian Museum, gave me detailed descriptions and drawings of the Australian cucullaeids as well as data on their geographical distribution. Dr. L. R. Cox, of the British Museum (Natural History), looked for the type specimens of *Cucullaea granulosa* Jonas. The following persons gave geographical data from the specimens of cucullaeids in their collections: Wm. J. Clench, Museum of Comparative Zoology; Dr. Leo G. Hertlein, California Academy of Sciences; and Dr. A. Myra Keen, Stanford University. This study could not have been completed without the help of these persons.

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MAMMALOGY.—*An undescribed pika from Utah.*[1] MARSHALL C. GARDNER. U S. Fish and Wildlife Service. (Communicated by Hartley H. T. Jackson.)

Albert W. Moore, of the Portland, Oreg., office of the branch of wildlife research of the U. S. Fish and Wildlife Service, recently suggested that certain pikas collected by him in 1928 in Utah might represent a new race. Upon examination they were found to be considerably different from *Ochotona princeps nevadensis*, the identification previously assigned to them. This new race is named in honor of Mr. Moore. Measurements are in millimeters.

Ochotona princeps moorei, n. subsp.

Type specimen.—Adult ♀, skin and skull, U.S.N.M. no. 248436, (Biological Surveys collection); collected July 18, 1928, 1 mile northeast of Baldy Ranger Station, Manti National Forest, altitude 10,000 feet, Sanpete County, Utah, by A. W. Moore; original number, 470. The station is 17 miles east and 2 miles south of Gunnison, Utah.

Geographic range.—Known only from the type locality.

Diagnostic characters.—Compared with *Ochotona princeps nevadensis*, the new subspecies is generally smaller in size and is less buffy on the sides. The nasals of *moorei* are shorter and are more rounded and less truncate posteriorly. The lateral margins are more concave and the palatal bridge is narrower. The subspecies *moorei* resembles *O. p. uinta* but is smaller and has less buffy upper parts and blacker ears. The skull is also slightly smaller with shorter nasals and with the anterior margin of the palatal bridge concave and not straight. From *O. p. saxatilis* it also differs in being generally smaller and having darker ears. The nasals are considerably shorter and the ventral surface of the basioccipital is not ridged as in *saxatilis*. The auditory bullae are more rounded. When compared to *O. p. utahensis* the body and skull are smaller, the hind foot longer, and the upper parts more buffy. The nasal length and palatal bridge width are less. In comparison to *O. p. clamosa* the new race is smaller and has the upper parts less blackish and more buffy. In the skull the lateral nasal margins are concave rather than straight, the interpterygoid space parallel-sided rather than spatulate and the auditory bullae less inflated. When compared to *O. p. cinnamomea* the head and neck are more buffy and the total length is less. The hind foot and skull are larger, however. The nasals are longer and more expanded anteriorly. *O. p. moorei* is more buffy on the head and neck than *O. p. fuscipes* with the throat less cinnamon and both the upper parts and under parts paler. The lateral nasal margins are more concave and the palatal bridge is broader. Finally, in comparison with specimens of *O. p. tutelata* from the Toyabe Mountains the new race has less cinnamon both dorsally and ventrally and has a longer hind foot. The skull is larger with longer nasals and with the lateral margins more concave.

Color.—(Capitalized terms according to Ridgway: *Color standards* and *color nomenclature.* 1912.) Type (worn winter pelage except for the head and shoulder which are acquiring the summer pelage): Upper parts near Light Ochraceous Buff. Under parts whitish washed with near Pinkish Buff.

Skull.—Medium in size; nasals short with lateral margins concave; anterior margin of palatal bridge concave; interpterygoid space parallel-sided.

Measurements.—Type (adult ♀): Total length, 177; foot length, 31; occipitonasal length, 43.0; zygomatic breadth, 21.3; cranial breadth, 18.5; interorbital breadth, 5.1; palatal bridge width, 2.0; nasal length, 13.8.

Specimens examined.—Three, from the type locality.

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[1] Received June 21, 1950.

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PHYSICS.—*The limitations of the principle of superposition.*[1] PAUL R. HEYL, Washington, D. C.

The principle of superposition, as applied in harmonic analysis, received its mathematical formulation at the hands of Fresnel in 1819. The conservation of energy did not come into physical thinking until the middle of the nineteenth century. In consequence, Fresnel's procedure gives rise, in some cases, to violations of the energy principle. The present article gives a study of these cases and suggests a method of handling them.

The principle of superposition dates back to Huygens (1678), but as applied in harmonic analysis it received its present accepted formulation at the hands of Fresnel in 1819.[2] According to this, the resultant of a number of simple harmonic vibrations is obtained by adding their amplitudes. This gives rise, in some cases, to a violation of the conservation of energy. For example, if we have two component vibrations, each with a periodic time of 2π seconds,

$$y_1 = \sin t \qquad y_2 = \sin t \qquad (1)$$

the energy of their resultant $y = 2 \sin t$ will be twice the sum of the energies of the components. But with the components

$$y_1 = \sin t \qquad y_2 = \cos t \qquad (2)$$

the resultant $y = \sin t + \cos t$ does not violate the energy principle.

In the general case of which (1) and (2) are special cases,

$$y_1 = \sin t \qquad y_2 = \sin(t - \theta) \qquad (3)$$

the excess (or deficiency) of energy in the resultant is equal to $\cos \theta$. From this it will be obvious that the addition of amplitudes may be valid in only a minority of cases. (Appendix 1.)

The reason for these violations of the energy principle is that in Fresnel's day the concept of energy and its conservation had not come into physical thinking. This did not happen until the middle of the nineteenth century. In 1847 Helmholtz published a paper entitled "Die Erhaltung der Kraft," and this name "conservation of force" lingered for some years after Rankine and Sir William Thomson introduced the term "energy" about 1850. Had Fresnel lived 50 years later he would naturally have added energies instead of amplitudes. In other respects also his article shows the rudimentary character of physical thought at that time. The dimensions of physical quantities were unknown to him. There are places where he adds to a time the ratio of two lengths. What is difficult to account for is the fact that the general adoption of the conservation of energy did not bring about a critical study and recasting of his formulation of the principle of superposition; but for this there may be a reason which will be mentioned later.

There are a few references in the literature of physics to these violations of the energy principle. Of these perhaps the most important is one giving Maxwell's views on the subject. The article "Harmonic Analysis" in the eleventh edition of the Encyclopaedia Britannica was written by Horace Lamb. The initials J. C. M. are signed to the earlier part of this article. In this part we find the following:

> The harmonic method may be defined in a more general manner as a method by which the solution of any actual problem may be obtained as the sum or resultant of a number of terms,

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[1] Received August 18, 1950.

[2] FRESNEL, *Mémoire couronné sur diffraction.* Oeuvres Complètes **1**: 286–293. 1819.

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each of which is a solution of a particular case of the problem. The nature of these particular cases is defined by the condition that any one of them must be conjugate to any other. The mathematical test of conjugacy is that the energy of the system arising from two of the harmonics existing together is equal to the sum of the energy arising from the two harmonics taken separately.

Maxwell died in 1879, and this edition of the Britannica was published in 1910. This statement by Maxwell does not appear in any other of his published writings. He may have included it in his article years later.

Components (1) are what Maxwell would call nonconjugate, as there is an excess of energy in the resultant; but components (2) are conjugate. Maxwell does not indicate any method for handling nonconjugate functions.

The usual methods of explaining away these violations of the energy principle are statistical in nature. An example is Rayleigh's article "Wave Theory of Light."[3] In this article he recognizes and formulates the difficulty, but says that in the case of light it may be avoided by a statistical treatment. He assumes n equal sine pulses of unit amplitude, and admits that if they are all in the same phase the amplitude of the resultant sum will be n and its energy proportional to n^2; but he says, in effect, "This will never happen." In the light from a candle, as he points out, we find all possible differences of phase in rapid succession, and he shows that in such a case the mean expectancy of intensity in the resultant will be proportional not to n^2 but to n. This will always be the case with light from any of the usual sources, consisting as they do of multitudes of atomic oscillators; but when we are dealing with sound waves, where the source, if not a single oscillator, consists of but a few such oscillators, Rayleigh's statistical treatment is not applicable. For such cases the method commonly used in treatises on optics is to integrate the resultant of two sources over a sphere surrounding them. Here the statistical element is not in the number of sources, but in the number of illuminated points in the integral. The objection to all such statistical treatments is that they avoid rather than explain the fundamental difficulty, and build up a satisfactory conclusion from basic assumptions which violate the energy principle. Such procedure suggests the proverbial statue with feet of clay.

Now if instead of construing the superposition principle to mean addition of amplitudes we use addition of energies the difficulty disappears; and on this basis we shall now develop a method for handling nonconjugate functions of equal frequency, such as those in (1), (2), and (3).

The difficulty in these cases can be overcome by applying modifying factors to the components before adding them. In case (1) the components are equal in energy and should therefore contribute equally to the energy of the resultant. Applying to each component the same factor M we obtain the modified components

$$y_1' = M \sin t \qquad y_2' = M \sin t$$

which by addition give the resultant $y = 2M \sin t$, whose energy is $2M^2$. This should equal the sum of the energies of the original components. We have then $2M^2 = 1$, giving $M = 2^{-\frac{1}{2}}$.

In case (2) there is no excess energy in the resultant sum. No modification is needed, and the factors come out unity.

In case (3) the factors come out $(1 + \cos \theta)^{-\frac{1}{2}}$. When $\theta = 0$ this equals $2^{-\frac{1}{2}}$ as in (1); and when $\theta = 90°$ the factors become unity, as in case (2). (Appendix 2.)

So much for components of equal frequency. For different frequencies different modifying factors are required. The mathematical analysis of such cases is quite intricate, and may be made the subject of a later paper.

With more than two or three components of different frequencies the mathematical labor involved rapidly mounts up; but fortunately it happens that in a number of cases of practical importance we can employ the traditional incorrect method and still obtain a correct result. Probably it is this curious fact which has long delayed the recognition of the limitations of the principle of superposition.

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[3] Written for the Encyclopaedia Britannica in 1888 and included in Rayleigh's Collected Papers **3:** 52.

For example, take tide prediction. The first thing to do is to obtain an experimental curve for the port. This is then analyzed harmonically, using the traditional method of superposition. The components thus obtained are synthesized by the traditional method after certain corrections are applied, and a resultant curve is thus obtained for some years ahead.

Now what happens here is that the components obtained by analysis of the experimental curve are what we may call artificial components—smaller than the real physical components. On reversing the process and synthesizing these artificial components by adding amplitudes we reverse the error previously committed and obtain a correct result. In cases like this it makes no difference whether we do or do not use modifying factors. It is of importance, however, that textbooks should state the correct fundamental theory of the subject.

In the present paper we have considered only vibrations of a particle. There are other applications of the superposition principle which the writer has investigated, and it may be sufficient for the present to sum up the conclusions.

In wave motion, similarly running waves are nonconjugate functions; but with equal and oppositely running waves, generating a standing wave, there is no violation of the conservation of energy.

With alternating currents the addition of amplitudes is valid in all cases, as is indicated by laboratory experiment. An alternating current and a simple harmonic vibration can both be expressed by the same graph—a sine curve; but with the shape of the graph the parallelism stops. The vibrating particle has constant energy at all instants of time, while the energy of the current is zero when either the current or the voltage is zero. In consequence, the energy laws in the two cases are different.

Appendix 1

Consider the general case of components (3). For a vibrating element of unit mass each component will have an energy of $\frac{1}{2}$, and the sum of the component energies will be unity. The resultant sum will be $y = \sin t + \sin (t - \theta)$, and its second derivative $d^2y/dt^2 = -y$ will be the force of restitution.

$$\text{Potential energy} = \int_0^y y\,dy = \tfrac{1}{2}y^2$$

$$= \tfrac{1}{2}\sin^2 t + \tfrac{1}{2}\sin^2(t - \theta) + \sin t \sin(t - \theta)$$

$$\text{Kinetic energy} = \frac{1}{2}\left(\frac{dy}{dt}\right)^2$$

$$= \tfrac{1}{2}\cos^2 t + \tfrac{1}{2}\cos^2(t - \theta) + \cos t \cos(t - \theta)$$

$$\text{Energy sum} = \tfrac{1}{2} + \tfrac{1}{2} + \cos[t - (t - \theta)]$$

$$= 1 + \cos\theta$$

Excess energy in resultant sum $= \cos\theta$. When $\theta = 0$, as in component (1), the excess energy equals unity; and when $\theta = -\pi/2$, as in component (2), the excess equals zero.

Appendix 2

Consider case (3), where the components are equal in energy.

$$y_1 = \sin t \qquad y_2 = \sin(t - \theta)$$

Applying equal factors M, we obtain the modified components

$$y_1' = M \sin t \qquad y_2' = M \sin(t - \theta)$$

whose resultant sum is

$$y = M[\sin t + \sin(t - \theta)]$$

Kinetic energy of resultant

$$= \tfrac{1}{2}M^2[\cos^2 t + \cos^2(t - \theta) + 2\cos t \cos(t - \theta)]$$

Potential energy $= \frac{1}{2}M^2y^2$

$$= \tfrac{1}{2}M^2[\sin^2 t + \sin^2(t - \theta) + 2\sin t \sin(t - \theta)]$$

Energy sum

$$= \tfrac{1}{2}M^2[1 + 1 + 2\cos(t - (t - \theta)]$$

$$= M^2[1 + \cos\theta)$$

This should equal the energy sum of the original components.

$$M^2(1 + \cos\theta) = 1$$

$$M = (1 + \cos\theta)^{-\frac{1}{2}}$$

When $\theta = -\pi/2$ components (3) reduce to (2), and $M = 1$; and when $\theta = 0$, $M = 2^{-\frac{1}{2}}$ as in (1).

METEOROLOGY.—*The trend in temperature at Washington, D.C., for 1862–1949.*[1]

RICHMOND T. ZOCH.

AVAILABLE DATA

There are published records of instrumental observations of temperature for Washington, D.C., beginning with 1817. However, a careful examination of the early records shows that little is known about the exposure of instruments or the rules used for taking and recording the observations. The late Dr. C. F. Marvin[2] once stated: "A true normal daily temperature can be computed with entirely sufficient accuracy only from a long series of values of 24 hourly temperatures for each day." If this statement is taken literally, then only two series of temperature observations are available in or near Washington, viz (1) the U. S. Weather Bureau Airport record of hourly observations beginning in 1928 and with the location of instruments in three different places since the beginning of the record; and (2) the U. S. Weather Bureau record at 24th and M Streets, NW., which began in March 1889.

A good approximation to 24 hourly temperatures for each day is given by three hourly observations. Beginning about 1840 the U. S. Naval Observatory made readings of the thermometer every three hours at its old location at 24th and E Streets, NW. These observations continued until 1892 when the Naval Observatory was moved to its present location on Massachusetts Avenue. At first it would seem that by supplementing the 24th and M Streets observation of the Weather Bureau with the 24th and E Streets record of the Naval Observatory that a total record length of more than 100 years (from about 1840 to date) would be available for studying the trend in temperature at Washington. It is true that these early temperature observations of the Naval Observatory are available for study, but according to J. R. Eastman,[3] for many years a member of the staff of the U. S. Naval Observatory, reliable observations by that institution did not begin until 1862. Because of this statement it was thought best to confine the Naval Observatory record used in this study to the period 1862–1892. It is believed that the record from 1862 to 1892 was one of the best, if not the best, records of temperature maintained in the District of Columbia up to and including that period. The observations were taken at the same location, by the same group of observers, with but few changes in the thermometers and, moreover, during this 31-year period the observers were under the supervision of the same man, viz, J. R. Eastman. This combination of circumstances is rather unusual to be maintained for such a long period of time, and so can be regarded as a quite homogeneous record.

ANALYSIS OF THE DATA

It will be noted that simultaneous records are available for four years, 1889–1892, at these two locations. The first step in analyzing the data was to compare the daily means computed from eight observations at 24th and E Streets, NW., with the means computed from 24 observations at 24th and M Streets, NW., for this 4-year period. It was found that there were differences and when these differences were tested for statistical significance they were found to be significant. The results of this comparison are given in Table 1.

Next, the records at the 24th and E Streets location were adjusted to make them comparable with the 24th and M Streets location. By making this adjustment it can be

TABLE 1.—COMPARISON OF DAILY TEMPERATURES AT 24TH AND M STREETS WITH 24TH AND E STREETS, 1889–1892

(Note: A minus sign means that 24th and E Streets is colder.)

Month	Number of observations	Average daily difference	Month	Number of observations	Average daily difference
		°*F*			°*F.*
January	124	−1.15	July	124	−0.01
February	113	−0.69	August	124	+0.20
March	124	−0.51	September	120	+0.48
April	120	−0.63	October	124	−0.10
May	124	−0.29	November	120	−0.58
June	120	−0.22	December	124	−1.05

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[1] Received September 14, 1950.

[2] Monthly Weather Rev. Suppl. 25: 1. 1925.

[3] Washington Astronomical and Meteorological Observations for the year 1866: Appendix 1, p. 2.

considered that 87 years of comparable records, viz, from March 1862 to March 1949, are available for a study of trend.

A quick analysis of the annual means of temperature will show that any observed trend in temperature, even though significant, is small. The question arises whether both positive and negative trends will be observed if the year is divided into a number of parts. Accordingly, the year was divided into 36 periods of 10 or 11 days each, three periods for each month (roughly) and means of temperature were computed for each period and for each year. These decade mean temperatures are available, but to save space they are not tabulated here.

A regression coefficient was then computed for each decade to ascertain whether there was any relation between temperatures and time. The results of these computations are given in Table 2.

Statisticians have devised tests to apply to regression coefficients in order to determine if the observed trend could have been

Table 2.—Analysis of Trend in Temperature

Period	Length of period	Average temperature for 87-year period	Trend °F. per annum (Regression coefficient)	Results of test for significance
	days	°F.		
Mar. 21–30	10	46.20	+0.1090	Significant at 99-percent level.
Mar. 31–Apr. 9	10	49.72	+0.0689	Do.
Apr. 10–20	11	53.17	+0.0436	Significant at 95-percent level.
Apr. 21–30	10	57.23	+0.0298	Not significant
May 1–10	10	60.99	+0.0550	Significant at 99-percent level.
May 11–21	11	64.20	+0.0392	Significant at 95-percent level.
May 22–31	10	66.71	+0.0309	Not significant
June 1–10	10	70.07	+0.0356	Significant at 95-percent level.
June 11–21	11	72.27	+0.0314	Not significant
June 22–Jul. 1	10	74.91	+0.0210	Do.
Jul. 2–11	10	76.05	+0.0044	Do.
Jul. 12–22	11	76.63	+0.0114	Do.
Jul. 23–Aug. 1	10	76.36	+0.0402	Significant at 99-percent level.
Aug. 2–11	10	76.04	+0.0246	Not significant
Aug. 12–22	11	74.41	+0.0187	Do.
Aug. 23–Sep. 1	10	72.38	+0.0262	Do.
Sep. 2–11	10	71.34	+0.0449	Significant at 99-percent level.
Sep. 12–22	11	67.86	+0.0394	Do.
Sep. 23–Oct. 2	10	63.56	+0.0128	Not significant
Oct. 3–12	10	59.76	+0.0325	Do.
Oct. 13–22	10	56.59	+0.0472	Significant at 99-percent level.
Oct. 23–Nov. 1	10	52.49	+0.0654	Do.
Nov. 2–11	10	49.15	+0.0610	Do.
Nov. 12–21	10	45.65	+0.0595	Do.
Nov. 22–Dec. 1	10	41.61	+0.0460	Significant at 95-percent level.
Dec. 2–11	10	38.46	+0.0460	Do.
Dec. 12–21	10	35.82	+0.0309	Not significant
Dec. 22–31	10	34.99	+0.0281	Do.
Jan. 1–10	10	34.16	+0.0793	Significant at 99-percent level.
Jan. 11–20	10	34.11	+0.0586	Significant at 95-percent level.
Jan. 21–30	10	34.11	+0.0120	Not significant
Jan. 31–Feb. 9	10	33.11	+0.0250	Do.
Feb. 10–19	10	35.50	+0.0313	Do.
Feb. 20–29	10	37.28	+0.0319	Do.
Mar. 1–10	10	39.66	+0.0419	Do.
Mar. 11–20	10	43.48	+0.0719	Significant at 99-percent level.

caused by chance. The results of these tests can be expressed by the degree of confidence, and this is shown in the last column of Table 2.

CONCLUSIONS

The tests of significance show that 12 of the regression coefficients are significant at the 99-percent level, 6 at the 95-percent level, while the remaining 18 were not significant. However, perhaps the outstanding result of these computations is that *all* 36 regression coefficients were positive. It can be concluded that the climate of Washington has been getting warmer.

It will be noted from Table 2 that the warmest half of the year is from April 22 to October 22. The average trend for this half is 0.0303° per annum. The average trend for the colder half is 0.0501° F. per annum. In the winter half four decades are significant at the 95-percent level and 7 at the 99-percent level. In the summer half only two decades are significant at the 95-percent level and only 5 at the 99-percent level.

It will also be noted from Table 2 that the warmest quarter of the year is from June 11 to September 11 for which the average temperature over this period of record was 74.49°F., and the coldest quarter is from December 2 to February 29 for which the average temperature was 35.28°F. Such a division makes the spring season two decades longer than the autumn season and if the year be divided into four seasons of nine decades each the following results are obtained:

Season	*Period*	*Average Temperature °F.*	*Average Trend °F. per annum*
Winter	Dec. 2–Feb. 29	35.28	0.0381
Spring	Mar. 1-May 31	53.48	0.0545
Summer	June 1–Sept. 1	74.35	0.0237
Autumn	Sept. 2–Dec. 1	56.45	0.0444

This study was based on data for the 87-year period ending March 21, 1949. The observed temperature for the year since this date tends strongly to verify the trend computed for the 87 years.

Acknowledgment—The writer is indebted to Robert F. Dale, of the U. S. Weather Bureau, for his advice and encouragement while this paper was prepared.

ARCHEOLOGY.—*An analysis and interpretation of the ceramic remains from site 38Mc6*[1] *near Clarks Hill, S. C.*[2] CARL F. MILLER, River Basin Surveys, Bureau of American Ethnology.

The pottery described in this report was obtained from a deeply buried site by the U. S. Corps of Engineers while widening the channel of the Savannah River prior to the construction of the Clarks Hill dam. The widening necessitated the removal of 250 feet of soil from the east bank of the river, upon which the main portion of the site was located.

The dam, now under construction, is located about 22 miles upstream from Augusta, Ga., near the southeastern margin of the Piedmont Plateau region of Georgia-South Carolina and about 20 miles above the "fall line." The topography of the reservoir area is typical of the eastern Piedmont.

The site is located on the immediate banks of the Savannah River opposite Clarks Hill, S. C., in the direct line of the main axis of the dam. The cultural deposit lies in the center of the site beneath 3.5 feet of clean, sterile river-deposited sand and silt, and resembles a shallow bowl in that the deposit gradually slopes upward to within a foot of the present surface. The cultural layer varies in thickness from 12 to 19 inches and is composed of a bluish-gray muck, containing the various artifacts. This deposit extends along the river bank for about 450 feet.

From the general appearance and nature of the deposit, it is surmised that the Indian inhabitants lived in an old slough. Whether they constructed some sort of pile dwellings cannot be determined, but the presence of such dwellings would explain the occurrence of artifacts within a slough-like deposit. When the site was gone over with a scraper a number of darkened circles appeared containing ash, unburned bones, potsherds, stone chips, and broken stones.[3] It was from these circles that most of the material for the present study was recovered.

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[1] Site designation used is trinomial in accordance with River Basin Surveys' methods in other areas. The first element, a number, indicates the State's numerical position in an alphabetical list of States, as 38 for South Carolina; the second, two letters, indicates the county symbol, as "Mc" for McCormick; the third is the number of the site within the series in that county.

[2] Published by permission of the Secretary, Smithsonian Institution. Received September 21, 1950.

A 6-foot square test pit was dug well into the undisturbed subsoil. It was noted that the upper portions of the muck deposit contained no artifacts or practically none to speak of. All the artifacts recovered came from the lower 4 to 6 inches of the deposit. It appears that the artifacts, as they were discarded and thrown into the slough, settled into the ooze and came to rest directly upon the clay subsoil. The material from the test pit was kept separate and used as a check on the material turned over to the Survey by the U. S. Engineers. There is no evidence of stratigraphy at the site, as all the sherds were in a compact layer at the bottom of the muck deposit.

Artifacts. An examination of the material recovered from the test pit shows the following traits:

Pottery:

Plain	42
Lamar Complicated Stamped	15
Savannah Complicated Stamped	5
Etowah Complicated Stamped	6
Clarks Hill Complicated Stamped	1
Indeterminate	5

Other Artifacts

Stone discoidal, quartz, smoothed	1
Hammerstone, quartz	1
Projectile point, small, quartz triangular	1
Projectile point, pointed base, quartz	1
Steatite pot fragment	1

The material turned over to the Survey by the U. S. Engineers shows the following traits, all ceramic:

Pottery:

Plain	511
Etowah Complicated Stamped	103
Savannah Complicated Stamped	28
Lamar Complicated Stamped	25
Savannah Check Stamped, Hollywood variant	25
Etowah Filfot Stamped	20
Clarks Hill Corncob Impressed	8
Clarks Hill Broad Line Stamped	3
Woodstock Linear Complicated Stamped	1
Deptford Linear Check Stamped	1
Clarks Hill Complicated Stamped	18
Indistinct	275
Indeterminate	18
Unidentified Check Stamped	7

Other Artifacts:

Steatite fragments	3
Celt, greenstone, fragmentary	2
Hammerstone, quartz	2
Atlatl weight, winged type, frag.	1
Discoidal, stone, crude, quartz	1
Discoidal, stone smoothed, quartz	1
Projectile point, pointed base, quartz	4
Projectile point, square base, chert, crude.	5
Projectile point, triangular base, quartz, small	3
Projectile point, ovate base, quartz, crude	2
Drill, ovate base, quartz	1
Graver, quartz	1
Awl, bone, fragmentary, bird	1

It is assumed that the 1,107 sherds upon which this report is based are representative of the whole deposit of the site. Though somewhat diverse in surface treatment, the pottery is rather homogeneous in paste, temper, color, and surface finish. It belongs to the sand-tempered ware which is representative of the latest ceramic horizon for this region, including the coastal part of South Carolina and Georgia and the interior of Georgia (Caldwell and McCann, 1941; Heye, Hodge, and Pepper, 1918; Kelly, 1938; Wauchope, 1948).

Varying amounts of sand were used as a binder in the clay, and the smoothness of the paste depends on the proportion of temper used. More sherds show that the matrix is evenly grained, well blended, and evenly fired than that a large amount of binder was used in an uneven blend. Occasional sherds have a dark core denoting uneven or incomplete firing, but as a rule the heat had been driven completely through the walls of the vessel. Fire clouds are very prevalent.

No handles of any description have been found at Clarks Hill. This characteristic deviates from that noted at other late sites, where strap handles were rather noticeable.

The elaborate rims encountered in the Lamar Complicated Stamped and in some of the Etowah Complicated Stamped sherds at the Lamar and Etowah sites are absent here. Most lips are simple, either rounded or flattened. No painted ware was noted.

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[3] Information for this statement was furnished by Malcolm Bascom, a member of the U.S. Engineer staff, who operated the scraper over the site.

A number of aberrant pottery types, which have not heretofore been reported upon, were noted at this site. Among these are "corncob"-impressed sherds which are also decorated with a very large, complicated, curvilinear stamped design, apparently a direct outgrowth of Swift Creek stamping (Fig. 1, *f–g*). In most cases, the corncob impression covers the neck and shoulder area of the vessel, with the stamped design blending in and apparently covering the rest of the vessel. The use of the corncob impression together with a complicated stamped design is unique. It is suggested that this type be called *Clarks Hill Complicated Stamped.*

In another instance the corncob impression covers the shoulder area and comes within a half inch of the lip, leaving the rest of the vessel plain (Fig. 1, *c*). In still another example, the corncob was rolled over the vessel exterior and then an attempt was made to obliterate the impression after the vessel had dried. Some sort of a rubbing tool was applied to the exterior in a haphazard manner leaving a series of diagonal and horizontal channels. These shallow channels do not cover the entire exterior and as a consequence small "islands" of corncob impressions are found, surrounded by semi-polished rubbing lanes. Where nothing but the corncob impression is used upon a plain base, it is suggested that the type be called *Clarks Hill Corncob Impressed* (Fig. 1, *c*).

A number of sherds have decoration resembling some of that from the Etowah mound (Ashley, 1932, fig. 82, *c*, *d*). No rim sections were found, but the decoration consists of a series of broad parallel lines interlaced with another set of parallel lines running at right angles to the first set and giving the whole a "basket-weave effect." This basket-weave effect appears on the exterior of rounded bottom, wide-mouthed jars. It is suggested that the type be designated *Clarks Hill Broad Line Stamped* (Fig. 1, *d*).

The paste of these aberrant sherds is more homogeneous than in most other specimens, being finer in texture and more compact. The clay in most cases has been well fired, in that the exterior and interior walls as well as the core, are of the same general color, a light buff. In a few instances the cores are black, showing the incomplete firing which occurs wherever firing clouds appear and the smudge is driven into the walls, causing the core to become darkened.

The exterior was roughly smoothed prior to stamping; it is rather rough and there are a number of holes formed as the vessel was being fashioned. The interior surface is well smoothed and all smoothing marks have been obliterated, leaving a fairly uniform surface. A number of firing clouds appear only on the interior of the sherds.

In the debris, a number of burned clay fragments, known as briquettes, were found, showing the impressions of small branches. The occurrence of briquettes suggests the presence of wattle and daub structures, which were common throughout the Southeast.

Conclusions.—Sites like the Clarks Hill site are usually thought of as falling within the last two of Georgia's aboriginal cultural periods, namely the Savannah II and Irene or Etowah, with the greatest stress on the last. In other words, this site is late prehistoric and early historic in time, and can be dated ca. 1540.

At the time of our visit, there was no evidence of any mound on the site. This in itself sets the site apart from the usual pattern noted for such sites as Irene, Lamar, and Etowah.

Nevertheless, the main decorative impetus seems to have come from the Etowah drainage and not from the Irene or Macon areas. A predominance of Etowah decorative motifs, shapes, and rim treatments is evident. Thus, the cultural trend was apparently down the river instead of in the opposite direction. Further investigations should be made along the upper reaches of the Savannah and Broad Rivers in order to test this hypothesis.

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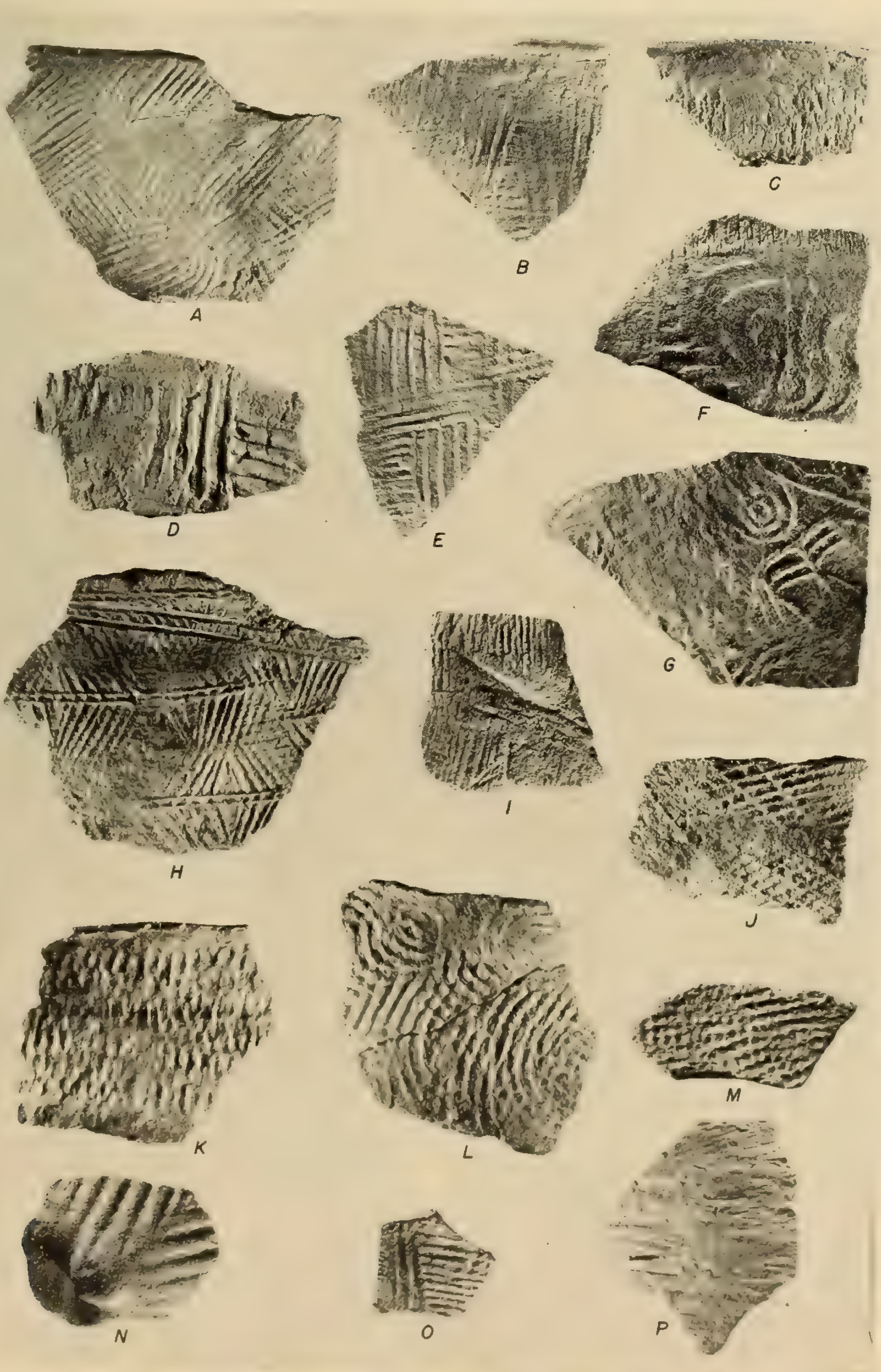

Fig. 1.—Pottery types from the Clarks Hill site, McCormick County, S. C.: *a*, Etowah Filfot Stamped; *b* and *e*, Savannah Straight Line Stamped; *c*, Clarks Hill Corncob Impressed; *d*, Clarks Hill Broad Line Stamped; *f* and *g*, Clarks Hill Complicated Stamped; *h*, Etowah Complicated Stamped; *i*, Simple Stamped; *j*, Savannah Check Stamped, Hollywood variant; *k*, fabric impressed; *l*, Savannah Complicated Stamped; *m*, Etowah Check Stamped; *n*, Deptford Linear Check Stamped; *o*, Woodstock Linear Complicated Stamped; *p*, brushed.

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BOTANY.—*Two new varieties of* Centropogon *from Colombia.*[1] E. Wimmer, Naturhistorisches Museum, Vienna. (Communicated by E. P. Killip.)

Dr. E. Wimmer, author of the monograph of Campanulaceae now in course of publication as a part of Das Pflanzenreich, has submitted the following diagnoses of two new varieties of *Centropogon*. The material upon which these are based was collected by members of the staff of the Facultad de Agronomía, Medellín, Colombia, and was submitted to Dr. Wimmer by the United States National Museum.—E.P.K.

Centropogon glaucotomentosus E. Wimm. var. **correana** E. Wimm.

Frutex scandens ozotrichus floribus aurantiacis. Superiores partes tomento plus minusve denso ferrugineo-virenti tectae. Folia elliptica, apice basique subacuminata, margine minute callose denticulata, supra demum glabrescentia, subtus imprimis in nervis dense tomentosa, 12 cm longa et 5 cm lata et minora. Flores in axillis foliorum superiorum solitarii. Pedunculi 40–45 mm longi, basi minute bibracteolati. Hypanthium depresso-globosum laciniis anguste lanceolatis 18 mm longis et in medio 2 mm latis subpatentibus. Corolla ca. 35 mm longa. Tubus filamentorum breviter pilosulus. Tubus antherarum 7 mm longus, atro-coeruleus, glaber, antherae 2 inferiores apice piloso-penicillatae. Bacca depresso-globosa, ca. 10 mm longa et 17 mm lata (in statu compresso).

Colombia: Dept. Antioquia, en selvas humidas y abiertas cerca San José de San Andres, 1.5.1948 lg. *J. Correa & M. Velásquez* 34—typus hb. Wien, Wash. Varietas differt a planta typica tomento parum leviore et minus glauco, antheris glabris.

Centropogon vulpinus E. Wimm. var. **sonsonensis** E. Wimm.

Planta tomento tenui tecta, folia supra glabrescentia. Pili ramosi. Lamina foliorum oblonga vel parum obovato-oblonga, apice acuta, basi angustata, margine callose denticulata, subtus in nervis lateralibus brevi-tomentella, ca. 15 cm longa et 4 cm lata. Flores in axillis foliorum superiorum solitarii. Pendunculi 50–60 cm longi, basi 2 bracteolis parvis praediti. Hypanthium depresso-globosum lacinis triangularibus integerrimis 3 mm longis. Corolla 40 mm longa. Filamenta breviter pilosula. Tubus antherarum 6 mm longus, glaber, 2 inferiores antherae apice barbatae.

Colombia: Dept. Antioquia, en chaparrál de páramo 10 km al norte de Sonsón, 2750 m s.m., 6.3.1948 lg. *G. Gutierrez, J. Correa & F. A. Barkley* 18 C 219—typus hb. Wien, Wash.—Varietas differt a planta typica follis basi attenuatis, pedicellis parum longioribus, sepalis integerrimis.

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[1] Received September 28, 1950.

BIOLOGY.—*Reactions of the golden nematode of potatoes,* Heterodera rostochiensis *Wollenweber, to controlled temperatures and to attempted control measures.*[1]

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The golden nematode, *Heterodera rostochiensis* Wollenweber, 1923, has long been known to cause damage to potatoes in northern Europe and in the British Isles. This nematode was discovered on Long Island, N. Y., in 1941 and at the present time it appears that this is the only infected area in the United States. Since 1941 the basic biology of this potato pest and various methods of control have been under investigation.

The present study is concerned only with cysts (i.e., dead females containing viable larvae capable of infecting potato plants) and (1) differences in their resistance to control measures, (2) inhibition of the hatching of their larvae, (3) hatching of their larvae at controlled temperatures, (4) overwintering as a factor in the life-cycle of the nematode, and (5) hatching of their larvae during winter.

It has long been known that "summer cysts" of the golden nematode (i.e., cysts collected during the summer season) differed from "winter cysts" (collected during the winter season) in their resistance to control measures, such as hot-water treatment. A more careful study of these differences was occasioned in December 1949 when, in cooperation with the Division of Foreign Plant Quarantines of the U. S. Department of Agriculture, an attempt was made to find suitable treatment for frozen shipments of lily-of-the-valley pips containing cysts of *H. rostochiensis*, being imported from the West Zone of Germany. Full results of these investigations will be published elsewhere. The present study, however, concerns summer and winter cysts taken from the soil of Long Island, N. Y., put through treating schedules to determine whether or not they differed in reactions to treatments.

Prior to 1947, B. G. Chitwood, in work conducted on Long Island, had washed cysts from soil for winter use during the previous summers. These cysts were maintained at room temperature until they were used in experiments during the winter. The same procedure was followed by the senior author of the present study during the winters 1947–1948 and 1949–1950 with one modification: the cysts were maintained at 70°F. in a constant-temperature chamber until the time they were used. Therefore when the treating schedule was started in December 1949, a supply of summer cysts was on hand. To secure the winter cysts, infected soil was removed from a field at Hicksville during the week of December 5, 1949, and allowed to thaw out in an unheated shed. The cysts were washed out of the soil through a U.S. Standard no. 60 sieve out-of-doors and transferred immediately to the laboratory refrigerator set at 40°F. Cysts of both categories were removed from their respective chambers immediately prior to being treated.

Cysts of each type, summer and winter, in one gram lots contained in small nylon bags, were exposed to hot water in a thermoregulator-equipped hot water bath, and to methyl bromide in a fumigation chamber. The bags exposed to hot water were pre-wet to insure the escape of air from them and were immersed in water at room temperature immediately after the exposure periods. After treatment, each lot of cysts was divided into two parts and examined for viability at periods varying from three to four weeks later. One half of each lot was examined under a binocular dissecting microscope and the numbers of viable and non-viable cysts counted, the presence of one or more viable larvae in any cyst indicating that the cyst was viable. The second half was exposed to the stimulatory effect of potato root leachings (O'Brien and Prentice, 1931) and checked twice weekly for evidences of larval hatching.

The two categories of cysts showed different reactions to control measures, the winter cysts exhibiting a greater resistance to various types of control measures than the summer cysts. Triffitt and Hurst (1935) state that exposures to water at 116°F. for

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[1] Report of a study made under the Research and Marketing Act of 1946. Received September 13, 1950.

45 minutes, 118°F. for 30 minutes and 130°F. for 5 minutes are lethal to the contents of the cysts of *H. rostochiensis*. In the present study, however, 116°F. for 45 minutes is a borderline treatment: two replications contained viable cysts of both categories after a two week exposure to leachings and two replications contained no viable cysts. The winter cysts show greater resistance to methyl bromide fumigation also, based on a thirty percent viability in the controls. An average of 23.8 percent of the winter cysts remained viable after exposures of four hours to four pounds per one thousand cubic feet of methyl bromide at normal atmospheric pressure and at 15 and 27 inches of vacuum. This represents a 20.7 percent kill of the formerly viable cysts. On the other hand, an average of 2.6 percent of the summer cysts remained viable when exposed to the same treatments, the kill, when compared to the control, being 91.3 percent.

This wide divergence in efficacy suggests one of the possible reasons why soil fumigation for the control of cyst-forming nematodes is more effective when applied immediately after a late summer or early autumn harvest, rather than in the spring before planting. Nematode cysts are in the summer condition late in summer and early in autumn and are more susceptible to soil treatments at that time. It is suggested that the proportionate increase of bound water within the larval protoplasm (at the expense of the free water), a device that Payne (1927a, 1927b, 1928), Robinson (1928), and Saccharov (1930) have shown to be a factor in the survival of insects at low temperatures, may be involved here. *Synchroa punctata* Newman and *Popillia japonica* Newman have been shown to be less susceptible to both extremes of temperature when most of their free water has been lost.

INHIBITION OF LARVAL HATCHING

Since golden-nematode cysts varied in their reactions to control measures, it was decided to investigate the effects, if any, of these treatments on the ability of larvae to hatch out of cysts. A search of the literature showed instances of inhibition of the hatching reaction of larvae of *H. rostochiensis* contained within the cysts. Carroll (1933) showed that exposure of cysts for two weeks to 1:100 and 1:250 parts of urea afterward resulted in complete inhibition of hatching. A 2-week delay resulted from exposure to 1:1000 parts. Hurst and Triffitt (1935) and Carroll and MacMahon (1937) found that ferric oxide added to potato root leachings delayed hatching. O'Brien and Gemmell, Prentice, Wylie (1939) state that a calcium chloroacetate treatment afterwards caused considerable delay in hatching. Smedley (1939) found that exposure of samples of one hundred cysts each to fumes of phenyl, ethyl or n-butyl isothiocyanate for 24 hours was sufficient to prevent hatching in potato root leachings afterwards for a period of two months; that exposure of samples to a 0.004 percent solution of ethyl isothiocyanate inhibited hatching for six weeks; and that the exposure of samples to 0.004 percent and 0.001-percent solutions of n-butyl isothiocyanate resulted in 24 larvae hatching after the 0.004 percent and 300 after the 0.001 percent. In the untreated control 8,500 larvae hatched out.

Cysts of both categories, winter and summer, used to check the efficacy of 4 pounds of methyl bromide per 1,000 cubic feet for four hours as a means of control were used in the present investigation. Cysts were treated on three separate occasions, and altogether seven treated lots were checked. Examinations for indications of viability were made in two ways: visually, under the binocular dissecting microscope, and by examining dishes containing treated cysts and potato-root leachings for the presence of hatched-out larvae.

With the aid of the binocular dissecting microscope, viable larvae were judged to be present in cysts of all of the treated lots. Untreated controls contained hatched-out larvae after 24 hours. Dishes containing cysts from three of the lots contained hatched-out larvae after a 1- to 2-week exposure to the stimulatory effect of potato-root leachings. Dishes containing cysts from the other four lots, however, did not contain hatched-out larvae in the same period. These cysts were then cut open in the leachings and viable larvae were found. These larvae exhibited motility when stroked with the shaft of a fine needle in the region of the circum-esophageal nerve ring. No explanation for these differing responses to potato-root leachings can be made at this time.

The results obtained with nematode cysts treated with four pounds of methyl bromide per 1,000 cubic feet for four hours indicate the existence of a period of inhibition of from one to two weeks after exposure to leachings. However, these cysts were exposed to leachings at periods varying from three to four weeks after treatment. Therefore, the total period of post-treatment inhibition may be longer when cysts are exposed to potato root leachings immediately after treatment.

It is possible that a revision of screening techniques for nematocides is in order. The absence of hatched-out larvae in treated material exposed to leachings at periods long enough to allow hatching in the controls cannot be considered as a definite indication of killing properties.

HATCHING AT CONTROLLED TEMPERATURES

There are several indications in the literature of the interrelations of temperature and the ability of *Heterodera* sp. larvae to hatch from cysts. Baunacke (1922) established two low temperature limits for the escape of larvae from cysts of *Heterodera schachtii* Schmidt: 10°C. for the escape of those that have hatched within the cyst and 18°C. for larvae that have to free themselves from their egg cases before they can escape from the cyst. These latter, according to the author, are not capable of movement as energetic as the former. Triffitt (1930), working with *H. rostochiensis* cysts that had been air-dried and stored in an unheated shed, concluded that a period of dormancy exists in the winter months during which time the larvae "will not hatch even under optimum conditions of temperature and moisture and in the proximity of potato root excretions." Miles (1930), in a study of "potato sickness" under field conditions associated intensity of root invasion with soil temperatures of 59°F. to 60°F. Since two categories of *H. rostochiensis* cysts, winter cysts and summer cysts, exist as far as resistance to hot water and methyl bromide treatments are concerned and since both categories show hatching responses to potato root leachings, it was decided to expose both categories to varying temperatures in leachings and in tap water to determine differences, if any, in hatching responses.

One gram lots of cysts, each containing approximately 300 viable cysts, were immersed in potato root leachings and in tap water in petri dishes at the following temperatures: 40°F., 50°F., 70°F., 80°F., and 100°F. The dishes were maintained at these temperatures for 16 hours in constant temperature chambers. At the end of the 16-hour period, the hatched larvae were separated from the cysts through a U.S. Standard no. 100 sieve and counted under the binocular dissecting microscope. The results are shown in Table 1.

The average numbers of hatched larvae from summer cysts show a significantly higher response, both to tap water and to potato-root leachings, at all temperatures.

Table 1.—Number of Heterodera rostochiensis Larvae Hatching at Controlled Temperatures during a 16-Hour Period in Tap Water and in Potato Root Leachings

Rep. No.	Summer cysts		Winter cysts	
	Tap water	Leachings	Tap water	Leachings
40°F				
A	32	31	4	5
B	55	25	3	9
C	38	20	4	7
Aver.	41.6	25.3	3.8	7.0
50°F				
A	53	41	6	1
B	47	30	20	3
C	33	54	8	3
Aver.	44.3	41.7	11.3	2.3
70°F				
A	109	205	4	7
B	113	188	2	4
C	110	201	1	6
Aver.	110.7	198.3	2.3	5.7
80°F				
A	53	131	3	9
B	60	83	1	14
C	73	95	4	9
Aver.	62.0	104.7	2.7	10.7
100°F				
A	54	40	3	13
B	40	47	0	2
C	44	44	3	3
Aver.	46.0	43.7	2.0	6.0

The stimulatory effects of tap water seem to be as marked as those of the potato root leachings at 40°F., 50°F., and 100°F. At the temperatures more commonly associated with the height of the growing season, however, potato root leachings do show a greater effect. The averages of the winter cysts show uniformly lower hatching responses at all of the temperatures both in potato-root leachings and in tap water.

A search of the literature dealing with dormancy in the invertebrates indicates that experimental work, thus far has been restricted largely to the insects. Payne (1927a, 1927b, 1928) found that survival of *Synchroa punctata* Newman at freezing temperatures is associated with the organism's ability to undergo dehydration. She specifies that the dehydration involves the loss of free water only. Cold hardiness was produced by experimental dehydration of individuals to half their body weights. Such individuals survived temperatures as low as −28°C. Robinson (1926) points out that low temperatures are believed to cause the streaming of free water from the cells to the intercellular spaces. Formation of ice crystals in the intercellular spaces causes death mechanically. Cold hardy species, on the other hand, can bind their water into hydrophilic colloids and freezing does not occur at these temperatures. Saccharov (1930) states that cold hardiness of insects depends on the presence of a minimum quantity of water and the ability of the organism to accumulate fat. All hibernating stages of insects prepare themselves to withstand cold by reducing the quantity of free, easily freezable water in their tissues. These facts suggest several of the processes possibly involved in the adaptation of *Heterodera rostochiensis* to temperature extremes. Since both categories of cysts can exist at the same time, it is assumed that the winter condition is not an inherent periodic manifestation in the life-cycle. The winter condition, rather, is due to the adaptation of the larvae to lower temperatures. Another possibility is that the winter condition (i.e., dormancy) does exist as an integral part of the life-cycle, its degree, however, being influenced greatly by temperature. It is not yet known how long an exposure to a significantly higher or lower temperature is necessary for the nematode to readjust from one type to the other.

The data on the invasion of potato roots by *H. rostochiensis* larvae during the less active period and the data on the hatching of larvae between 40°F. and 100°F. are being augmented by work now in progress to determine the actual limits of activity of the nematode.

OVERWINTERING AS A FACTOR IN THE LIFE-CYCLE

An experiment was set up to determine whether or not overwintering, i.e., exposure to Long Island, N.Y., winter soil temperatures of 30°F–50°F, might play a role in the activation or maturing of larvae within cysts of *Heterodera rostochiensis.*

Pots containing potato seed pieces and sterile nematode-free soil were inoculated with large uncounted numbers of viable golden nematode larvae on September 16, 1949. The pots were kept in the greenhouse until December 1949. After the tops of the plants had died back, the pots were brought into the laboratory. At no time were the pots exposed to temperatures lower than 55°F. During April 1950, the nematode cysts, all of which had developed during the period between September and December 1949, were washed from the soil. Some were exposed to potato root leachings and others were placed in contact with potato seed pieces in nematode-free soil.

Subsequently, the dishes of cysts and leachings contained hatched larvae within two days and the seed pieces in infected soil bore white nematode cysts in early May 1950, indicating that soil temperatures between 30°F and 50°F under Long Island, N.Y. conditions play no part in the activation or maturing of larvae of *H. rostochiensis.*

HATCHING DURING WINTER

The life-cycle of *Heterodera rostochiensis* has been studied in detail by Chitwood and Buhrer (1946). They state that the course of the individual life-cycle, the period from embryonated eggs to embryonated eggs, may be not less than 38 days and does not exceed 48 days. In this study, Chitwood and Buhrer's observations were compared with the course of the life-cycle of the nematode during the winter. Their findings are confirmed in the present study by the results obtained with the use of winter cysts.

Soil containing golden nematode cysts was dug from the laboratory's infested field on January 8, 1950. At that time, the top three inch layer of soil was frozen and the temperature of the underlying soil was 33°F to 34°F. The soil was allowed to thaw out overnight in an unheated shed and the cysts were washed out on January 10, 1950. The cysts were then combed through sterile nematode-free soil. Potato seed pieces of the Katahdin variety in which dormancy had been broken were planted in six inch pots in this soil on the same day. The pots were kept in benches in the greenhouse where temperatures fluctuated between 50°F and 65°F during the growing period.

On March 10, 1950, white cysts were observed at the exterior of the root balls. On March 23, 1950, 72 days after the planting date, the cysts were of a deep yellow color and contained embryonated eggs (Fig. 1). Four to five weeks may be allowed for the appearance of potato roots at the exterior of a 6-inch soil ball. Therefore, larvae from cysts near the exterior of the soil ball entered

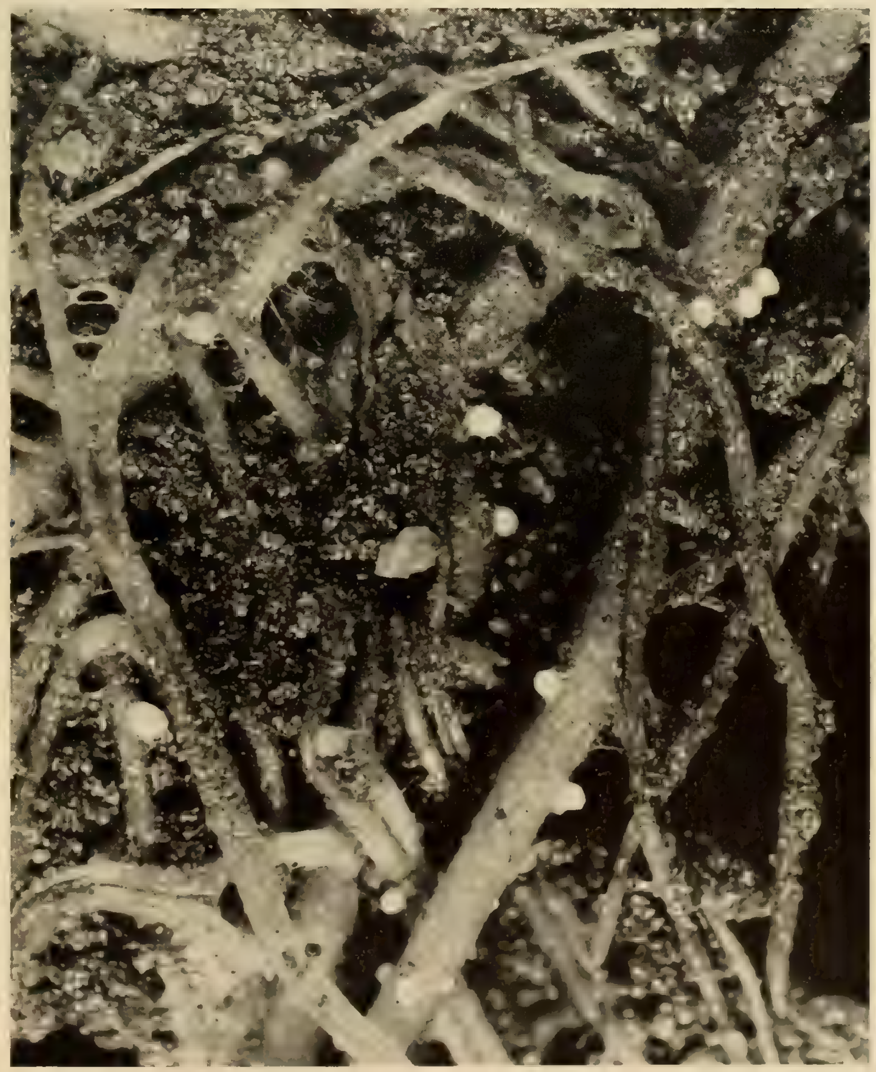

Fig. 1.—Root ball of Katahdin potato plant with cysts of the golden nematode attached. Pictures taken March 23, 1950.

external roots growing out toward them in the four to five weeks after the planting on January 10. Yellow cysts containing embryonated eggs formed during a period of 37 to 44 days after the 4- to 5-week period.

In addition to the qualitative work mentioned above, a quantitative study showing that the nematode can reproduce at normal rates during the winter was made by the senior author of the present study (1949). Potato-seed pieces were exposed to known quantities of cysts in nematode-free soil in pots. The pots were kept in eight constant-temperature tanks in which temperatures were maintained by thermo-regulators. Each tank held eight pots containing cyst inocula of 1, 5, 16, 32, 450, 9000, 22,500, and 45,000 viable cysts, respectively. The rates of increase of new generation cysts resulting were inversely proportional to the quantity of inocula, the average rate of increase in pots with one viable cyst being 45.0 times the inoculum and the averge for the 45,000 cysts being 1.74 times the inoculum. The average rates of increase by tanks were as high as 13.6, with five of the tanks showing a rate of increase of 10.5 or better.

These observations serve as an indication that golden nematode cysts in the winter condition (from soil at freezing and near freezing temperatures) will infect potato roots when kept at temperatures approximating those of the normal growing season.

SUMMARY

Experiments were conducted which indicate that:

1. Cysts of the golden nematode, *Heterodera rostochiensis*, fall into two categories as far as susceptibility to methyl bromide fumigation and hot water treatments are concerned: the contents of winter cysts maintained at approximately 40°F. being less susceptible to control measures than those summer cysts maintained at 70°F.

2. Exposure of larvae within cysts to sublethal control measures may afterward cause an inhibition of the hatching response in potato-root leachings.

3. Golden nematode larvae will hatch out at temperatures as low as 40°F. when exposed to potato-root leachings and to tap water for 16 hours.

4. Larvae of 1-year-old cysts do not have to overwinter under Long Island, N.Y., field conditions in order to hatch out.

5. Larvae of cysts removed from field conditions in January 1950, when soil temperatures were at the freezing level, hatched out and infected potato roots during the same month under greenhouse conditions.

6. Hatching of golden-nematode larvae occurs under controlled temperatures during the winter months. Rates of reproduction compare favorably with those of natural infections during the summer.

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ENTOMOLOGY.—*Notes on Trichopodini (Diptera, Larvaevoridae), with description of a new parasite of cotton stainers in Puerto Rico.*[1] Curtis W. Sabrosky, Bureau of Entomology and Plant Quarantine.

In Puerto Rico attempts were made in 1941 and 1942 to introduce from Peru a larvaevorid fly, *Acaulona peruviana* Townsend, as a parasite of cotton stainers, *Dysdercus* spp. Subsequent collections to determine whether that species had become established revealed the presence of an undescribed parasite, apparently a native species. In the taxonomic study of this new species, the New World genera of the tribe Trichopodini (*sensu* Townsend) were reviewed, and although a complete revision is not possible at this time, some results may be of aid to other workers in the future.

For convenience, the present paper is confined to the Trichopodini in the sense of Townsend. Certainly some genera of Townsend's Phasiini, however, are much closer to Trichopodini than to other phasiine genera, especially in the type of male and female genitalia (e.g., *Ectophasiops* Townsend). A similar distinction has been pointed out by Brooks and by Dupuis in recognizing two groups of genera within the Phasiini, based on reproductive habit and type of female genitalia. A natural grouping would seem to call for considerable rearrangement, with combination of parts or all of several tribes.

In almost all proposed genera of the Trichopodini either the fundamental structure is so similar or the characters so overlap that one must perforce either synonymize extensively or, with Townsend, construct unsatisfactory keys on variable and ineffective characters. One feature that seems not to have been used previously is the chaetotaxy of the scutellum, and this is so markedly different in two groups that it is a significant and highly useful initial division. In some cases, also, it is possible that differences in the form of the genitalia may justify generic recognition.

Complete citations of genotypes have been omitted for purposes of this contribution. They are given in full in Townsend (*Manual of myiology*, pt. 7: 9–35. 1938).

KEY TO THE NEW WORLD GENERA OF TRICHOPODINI

Key to Groups

1. Scutellum with basal scutellar bristles much longer than apicals, widely divergent, and inserted midway between basal corner of scutellum and apical bristles (Fig. 8); apical cell long petiolate. *Xanthomelanodes* complex
   Scutellum with basal bristles not obviously longer than apicals, directed posteriorly or curving mesad, and inserted quite near basal corner of scutellum (Fig. 9); apical cell open, closed at margin, or very short petiolate. . 2
2. Posterior tibia ciliate dorsally with a row of close-set, flattened bristles, which may or may not be obviously longer than diameter of tibia . . . . *Trichopoda* complex
   Posterior tibia entirely without flattened bristles. . . . . *Acaulona* complex

Xanthomelanodes Complex

1. Second segment of arista elongated, 3 times length of basal segment and 5 times it own breadth; third antennal segment elongated, 3 times length of second segment. *Xenophasia* Townsend
   First 2 segments of arista short; third antennal segment not elongated. *Xanthomelanodes* Townsend

Trichopoda Complex

1. Postcoxal area, between hind coxae and first abdominal sternite, membranous and characteristically sunken or shriveled; front somewhat narrowed at vertex, the sides parallel on basal half, then suddenly diverging (Fig. 4) 2
   Postcoxal area sclerotized, the lateral plates not distinctly separated by a sunken, membranous or weakened area; front not as

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[1] Received September 15, 1950.

above, sides either subparallel throughout (Fig. 5), or widely diverging from vertex . . 4

2. Female with anal cerci widely separated basally, but with elongate, slender, converging apical portions, the eighth sternite polished black, triangular, with tip slightly recurved (Fig. 1); abdomen moderately slender and cylindrical in both sexes, habitus wasplike . . . . *Polistomyia* Townsend

Not so, the female cerci broadly approximated, without fingerlike prolongations; eighth sternite of female distally broadly rounded or truncate; habitus not wasplike 3

3. Anal cerci of female thick, posteriorly flattened structures ("heavy blocklike and obliquely truncate"—Townsend), flattened surfaces densely covered with fine short hairs arranged in rows (Fig. 3); eighth sternite of female short and broad, distally truncate; fused anal forceps of male not deeply notched distally, sloping basad from median process; wing moderately broadly hyaline along hind margin . . . . *Eutrichopoda* Townsend

Anal cerci not so, thin and platelike, sparsely haired (similar to Fig. 2); eighth sternite subquadrate, broadly rounded distally; fused anal forceps of male distinctly notched distally, with short thick median process and well-developed lateral angles; wing largely infuscated, including all or virtually all of discal and apical cells . . . *Trichopoda* Berthold

4. Only one strong sternopleural bristle, sometimes a much weaker anterior bristle; squamae gently rounded on hind margin; a "*Plecia*-counterfeit": black wings with clear areas in submarginal, first posterior, and discal cells . . . . *Bibiomima* B. B.

Two or three strong sternopleural bristles; squamae broadened and squared behind, hind margin straight or even slightly concave 5

5. Abdomen short-ovate, heavily pollinose; hind tibia with several strong bristles basad of flattened cilia in same row, the cilia short and only on distal third or less; hind tibia with 3 long anterodorsal and 3 long posterodorsal bristles; wing nearly clear, only faintly browned anteriorly.
Atrichiopoda Townsend

Abdomen generally longer; hind tibia not with bristles basad of cilia, but with isolated cilia and hairs that gradually decrease in size to base of tibia; 1 or 2 anterodorsal and posterodorsal bristles on hind tibia 6

6. Wing distinctively marked, broadly bright yellow midway of wing, the distal two-fifths to half of wing infuscated, especially on costal half . . . . *Syringosoma* Townsend

Wing otherwise marked, either entirely infuscated along costal third to half of wing, or whole wing more or less infuscated 7

7. Abdomen slender, cylindrical, the thorax also proportionately slender, the general aspect of fly like a slender *Cylindromyia*.
Tapajosia Townsend

Not so, the abdomen broader, often short and oval 8

8. Female genitalia as in Fig. 7, the eighth sternite elongated and strongly curved; median process of fused anal forceps of male knobbed apically, as seen in posterior view; wing of male not broadened basally.
Cylindrophasia Townsend

Female genitalia not so (unknown for *Homogenia*), the anal cerci broad and platelike, and eighth sternite short and neither strongly curved nor distally sinuate; males as far as known without knobbed median process on anal forceps . . . . . . *Homogenia* Van der Wulp
(=*Euomogenia* Townsend)
Pennapoda Townsend
Platyphasia Townsend

Acaulona Complex

1. Dorsocentral bristles 2 + 3, long and strong, nearly subequal, occasionally anterior presutural and anterior postsutural shorter and weaker but still distinct 2

Not so, usually 1 + 1 strong bristles, or 1 + 2, anterior postsutural position without a bristle 4

2. With more or less distinct median marginal bristles on abdomen 3

No median marginal bristles present (at least in female, the only sex known); cerci broad and platelike (Fig. 2).
Melanorophasia Townsend (*s. str.*)

3. Body slender, abdomen usually very slender and tapering; female cerci broad, platelike (near Fig. 2); eighth sternite of female short and inconspicuous.
Xanthomelanopsis Townsend

Body broader, abdomen relatively shorter and broader; female cerci long, slender, and tapering; eighth sternite of female long, thin, polished, curving backward at tip.
Urucurymyia Townsend

4. No distinct median marginals on intermediate abdominal segments; female genitalia as in Fig. 6, the eighth sternite modified as a stout piercer . . . . *Acaulona* Van der Wulp
(? = *Forcipophasia* Townsend)

Distinct median marginal bristles on at least some of abdominal segments 5

5. Squamae boot-shaped, strongly widened posteriorly, inner angle nearly a right angle, outer angle produced; fused posterior forceps of male with a dorsoventrally flattened median process, but not deeply notched laterad of the process (female unknown to me).
Euacaulona Townsend

Squamae not suddenly widened behind, outer margin nearly straight, hind margin weakly rounded; distal margin of fused posterior forceps of male deeply notched, and median process laterally compressed with enlarged tip slightly recurved; female genitalia as in *Xanthomelanopsis*, cerci broad and platelike (near Fig. 2) . . . . *Itaxanthomelana* Townsend

Xanthomelanodes Complex

Genus **Xanthomelanodes** Townsend (1893)

Xanthomelana Van der Wulp, Tijdschr. Ent. **35**: 189. 1892. Preoccupied.
Xanthomelanodes Townsend, Can. Ent. **25**: 167. 1893.
Erythrophasia Townsend, Ins. Insc. Menstr. **4**: 127. 1917.

Townsend's replacement name was originally proposed on the ground that *Xanthomelana* was invalidated by its close similarity to *Xanthomelon* Martens (1860) in Mollusca, a position that was soon abandoned. Later (1908) Townsend stated that *Xanthomelana* was preoccupied by *Xanthomelana* Bonaparte (1850) in Aves, and still later (1938) that it was preoccupied by *Xanthomelana* Cabanis (1851) and Waterhouse (1889), also in Aves. Accordingly, Townsend used *Xanthomelanodes* in major works in 1897, 1908, 1927, 1936, and 1938; in the same period, *Xanthomelana* Van der Wulp was used by Coquillett (1897), Van der Wulp (1903), Aldrich (1905), Adams in Williston (1908), Coquillett (1910), and Curran (1934).

The references in Aves cited by Townsend have been examined in detail. In Bonaparte (Conspectus generum avium, **1**: 446–447, 1850, the genus *Euplectes* was divided into two parts, "*Pyromelanae*" with seven species and "*Xanthomelanae*" (p. 447) with four species. These indeed appear to be intended subgenera, though headed by names in the plural. The later references cited the second name as *Xanthomelana*, usually with a reference to Bonaparte, 1850 (Cabanis, Museum Heineanum, pt. 1: 177. 1851; Waterhouse, Index generum avium: 234. 1889; Horsfield and Moore, Cat. Birds Museum East India Co. **2**: 519, 1856–1858). In Cabanis and in Horsfield and Moore, *Xanthomelana* is cited in generic synonymy, and in the second work also in a specific synonymy as "*Euplectes* (*Xanthomelana*) *xanthomelana*." Even if the name is not considered available as of 1850, which some will accept, it must still be considered as dating from some one of the other works by citation in synonymy or by indication, and accordingly sa preoccupying *Xanthomelana* Van der Wulp (1892).

It is quite probable that some of Van der Wulp's Mexican species will prove to be the same as some species in the following key. I have seen specimens from San Rafael, Veracruz, that I cannot distinguish from *arcuata* and *atripennis*, and one of Van der Wulp's species may be the same as *X. californica* Townsend. Of Van der Wulp's six species of *Xanthomelana*, *anceps* is the type of *Vanderwulpella* Townsend, and another species, *articulata*, appears to me from the description and figure to belong in *Xenophasia*, leaving four species still to be reckoned with in *Xanthomelanodes*.

Males predominate in the collections that I have seen. Of 108 available specimens of the four species included in the key, there are 81 males and 27 females.

KEY TO XANTHOMELANODES OF THE UNITED STATES

1. Legs predominantly yellow, femora entirely so or only obscurely browned at knee, tibiae partly yellow to brown; antenna almost entirely yellow........*flavipes* (Coquillett)
   Legs predominantly black, tibiae and tarsi entirely so and femora black on distal half or more; antenna almost entirely black... 2
2. Front relatively narrow, at vertex 0.19–0.22 times the width of head (average 0.21) (eastern).....................*arcuata* (Say)
   Front broader, at vertex 0.24–0.285 times head width (average 0.246 and 0.257 for the two species)................................ 3
3. Cerci of male united, with median process distally; female cerci flat, platelike, short and acutely pointed, as in *arcuata* (cf. Fig. 11); typically 3 sternopleural bristles; usually 1 strong bristle below each vibrissa (western) *californica* Townsend
   Distal margin of united male cerci arcuate, without median process; platelike cerci of female elongate and slightly hooked at apex (Fig. 10); typically 2 sternopleurals; no strong bristles near the vibrissae (eastern) *atripennis* (Say)

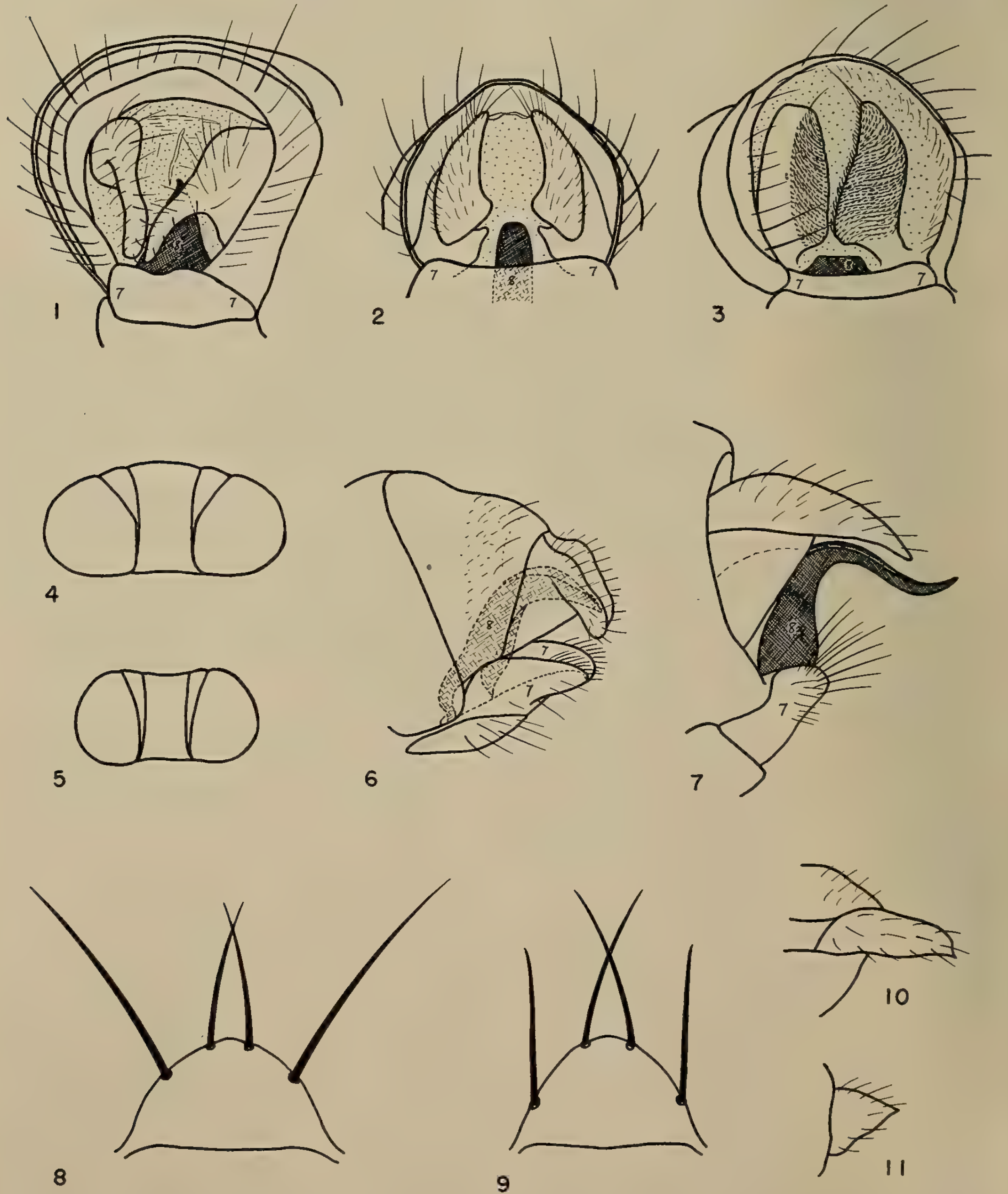
Xanthomelanodes flavipes (Coquillett)

Xanthomelana flavipes Coquillett, U. S. Dept. Agr. Div. Ent. Techn. Ser. Bull. 7: 72. 1897. (Mass.)

The distinct coloration of legs and antennae of this species stands out in the genus. The species appears to be most closely related to *arcuata*, having typically three sternopleural bristles, one bristle (the vibrissa) on each side of the face, front even narrower than in *arcuata* (0.176 and 0.186 in the two good specimens available, the type and paratype), united cerci of male with median process, and female cerci short and broad.

The few published records and available specimens are from the northeast (Mass., Vt., N. Y., Quebec).

Type male and paratype female (abdomen now missing), Horseneck Beach, Mass., August 4, 1896 (Hough). Type U. S. N. M. no. 3568. The male bears the original Museum type label and Coquillett's name label, both written by Coquillett. Inasmuch as Coquillett did not state the sex of the type, saying only "a specimen of each sex . . . Type No. 3568," some may not accept that as designating the holotype and may prefer to regard the present listing as lectotype designation.



Figs. 1-11.—Trichopodini: 1-3, Posteroventral aspect (slightly lateral in 1 and 3) of female genitalia of *Polistomyia plumipes* (1), *Melanorophasia minuscula* s.str. (2), and *Eutrichopoda* sp. (3); 4, 5, dorsal aspect of head of *Trichopoda pennipes* (4) and *Acaulona peruviana* (5); 6, 7, side view (slightly posterodorsal in 6) of female abdomen of *Acaulona brasiliana* (6) and *Cylindrophasia simillima* (7); 8, 9, scutellum of *Xanthomelanodes arcuata* (8) and *Acaulona peruviana* (9); 10, 11, cercus of female. *Xanthomelanodes atripennis* (10) and *X. arcuata* (11).

Xanthomelanodes californica Townsend

Xanthomelanodes californica Townsend, Smithsonian Misc. Coll. **51**: 129. 1908.
? = *Stevenia pictipes* Bigot, Ann. Soc. Ent. France **42**: 254. 1888.

A small species, apparently closest to *X. arcuata*, with three sternopleurals and similar male and female terminalia, but with wider front and almost always with two pairs of bristles on the sides of the face.

Distribution: Western, Washington to California and east to Colorado, as far as known.

Stevenia pictipes Bigot from Washington Territory was placed by Coquillett (1897) as a synonym of *X. arcuata* (Say), but it might be either *californica* or *arcuata*.

Xanthomelanodes arcuata (Say)

Ocyptera arcuata Say, Journ. Acad. Sci. Philadelphia **6**: 173. 1829.

In addition to the narrow front, the species is characterized as follows: Typically three sternopleural bristles; abdomen strongly black marked, including the base, median dorsal spots on first two segments, and more of the third and fourth segments, in the female including nearly the whole tergite on the latter two segments; cerci of male united and with a median process distally; female cerci flat and platelike, short and acutely pointed (Fig. 11).

This species and *X. atripennis* have apparently been confused in many determinations because of some variation in color and in the number of sternopleural bristles. The two are quite distinct in both sexes, however, as noted in the key.

Townsend (Ins. Insc. Menstr. **4**: 126. 1917) placed *Wahlbergia atripennis* Townsend as a synonym of *arcuata*, after having regarded it in his earlier papers as a synonym of *X. atripennis* Say. From the lectotype of Townsend's species, I refer it back to *atripennis* Say (q.v.).

Distribution: Eastern, at least chiefly. Specimens before me are from Arkansas, Colorado, Illinois, Indiana, Kansas, Maryland, Massachusetts, Mississippi, New Hampshire, New Jersey, Texas, Virginia, Wisconsin. A headless specimen from San Rafael, Veracruz, Mexico, and a single specimen from Seattle, Wash. seem to belong here also.

Xanthomelanodes atripennis (Say)

Phasia atripennis Say, Journ. Acad. Sci. Philadelphia **6**: 172. 1829.
Wahlbergia atripennis Townsend, Proc. Ent. Soc. Washington **2**: 145. 1891. (D. C.).
Erythrophasia atripennis Townsend, Ins. Insc. Menstr. **4**: 127. 1917.

This species is sometimes confused with *X. arcuata*, as noted under that species, but is quite distinct in both sexes. The front is broader, at the vertex 0.245–0.285 times the width of the head (average 0.257); abdomen predominantly deep yellow to orange, sometimes with a dorsal row of obscure, indistinctly bounded brown spots, and occasionally discolored apically.

The history of the species has been somewhat confused by the use of the same specific name, *atripennis*, in three independent proposals, plus the fact that Townsend for many years considered his 1891 species a synonym of Say's species, and then later referred it to *arcuata* and redescribed Say's species as *Erythrophasia atripennis*. In my opinion all three are the same species. Types of both of Townsend's names are before me, and although Say's descriptions are inadequate from modern standards, the presence of only two common eastern species makes it possible to identify them with reasonable certainty.

I question the synonymy of *Tachina corythus* Walker, which Coquillett (1897) placed as a synonym of *X. atripennis* (Say). Walker's description states that the palpi of *corythus* are black and the wing dark gray with brown stripes along the veins, which does not sound like *Xanthomelanodes* at all.

Distribution: 38 specimens are before me from Arkansas, District of Columbia, Florida, Georgia, Maryland, New Jersey, and Virginia. One specimen from San Rafael, Veracruz, also seems to belong here. Most of the specimens were collected in August and September.

The four specimens of the original type series of *Wahlbergia atripennis* Townsend have been examined, one in the collection of the U. S. National Museum, and three from the Snow Collection, University of Kansas, lent through the courtesy of Dr. R. H. Beamer. All four are males. One in the Snow collection has been labeled as, and is hereby designated as lectotype, the other three as lectoparatypes.

Xanthomelanodes brasiliensis Townsend

Xanthomelanodes brasiliensis Townsend, Rev. Chilena Hist. Nat. **32**: 371. 1929.

In the type series before me I hereby designate as lectotype a male, Itaquaquecetuba, São Paulo, Brazil, December 6; lectoallotype, May 6, and three lectoparatypes, May 21 (♂), May 29 (♂), June 3 (♀), all topotypic (C. H. T. Townsend). All specimens have Townsend name labels, and the lectotype and lectoallotype bear red labels as "Type," but in this case Townsend failed to specify which was the holotype, either by publication or label.

TRICHOPODA COMPLEX

Trichopoda typica: Postcoxal area membranous

In this typical division of the *Trichopoda* complex the dorsal aspect of the head is characteristic, the front narrowed above with sides of front parallel on basal half, then suddenly diverging (Fig. 4); no outstanding median marginal bristles on intermediate abdominal segments, all marginal bristles being short and subequal; apical cell either short petiolate or closed at margin of wing, in either case the juncture with costa is slightly before the apex of the wing; hind crossvein more or less sinuate; hind tibia dorsally with long, flattened, scalelike cilia.

Genus **Trichopoda** Berthold

Trichopode (vernacular!) Latreille. Familles naturelles du règne animal: 498. 1825. ("*Thereva lanipes*, F.; ejusd., *t. plumipes*.")

Trichopoda Berthold, German translation of Latreille (1825), as "Natürliche Familien des Thierreichs mit Anmerkungen und Zusätzen von Dr. Arn. Ad. Berthold": 508. 1827. ("*Thereva lanipes*, Fab. *Thereva plumipes*, dess.")

Trichiopoda Latreille, Règne animal **5**: 512. 1829. (*Thereva plumipes* and *lanipes* of Fabricius, with several other species.)

Trichopodopsis Townsend, Journ. New York Ent. Soc. **21**: 148. 1913.

This genus has often been cited as *Trichiopoda* Latreille, but the first publication in proper Latinized form was by Berthold in translating Latreille (1825). The generic names in Latreille's work are in the vernacular, and cannot be accepted; it seems, therefore, that the name must be credited to Berthold (1827) with the spelling *Trichopoda*.

Townsend recognized *Trichopodopsis* for *T. pennipes* (Fabricius) and related species, but my studies have furnished no support for segregating these species from typical *Trichopoda* s. str.

The genus is widely distributed in the Nearctic and Neotropical Regions. Despite the commonness of some of the "species," there are still some puzzling problems of color pattern and possible erroneous association of sexes.

Genus **Eutrichopoda** Townsend

Eutrichopoda Townsend, Smithsonian Misc. Coll. **51**: 134. 1908.

The distinctive female cerci (Fig. 3) suggest that this group deserves separate status. The few specimens known to me are Neotropical except for one example from Panama City, Fla.

Eutrichopoda abdominalis Townsend, Rev. Chilena Hist. Nat. 32: 371. 1929. Lectotype female, here designated, "Mb. [Moyobama, Peru] 13.XI Rio Mayo Foliage." Lectoparatype, male, "Fls. Baccharis g Itq. 3.VI" [Itaquaquecetuba, São Paulo, Brazil, June 3, on flowers of *Baccharis genistelloides*]. Both in U. S. National Museum. The female was selected as the lectotype after studies showed that *Eutrichopoda* is probably a valid grouping based on the form of the female genitalia. The male is the one associated by Townsend, but I am not sure that the association is correct.

Trichopoda atypica: Postcoxal area closed

Genera of the *Trichopoda* complex, which are atypical with respect to the postcoxal area, also have the following characteristics: In dorsal aspect, the sides of the front either subparallel throughout (as in Fig. 5) or widely diverging from the base; abdominal segments generally with strong erect median marginal bristles (absent in *Atrichiopoda* and perhaps in some others; small in *Pennapoda;* may be smaller in females than in males of same species); apical cell open, either broadly or narrowly, occasionally closed at margin, and rarely (*Bibiomima*) petiolate, in any case the third vein curving posteriorly so that it ends precisely at the apex of the wing and not before (slightly atypical in *Platyphasia*); hind crossvein more or less sinuate; cilia on hind tibia usually short and confined to the distal third to half of the tibia, much less conspicuous than in the typical *Trichopoda*.

I suspect that some of the genera included here should be synonymized, but until the classification in this group is much clearer than at present it seems best to identify them as far as possible with present information. Several genera, such as *Atrichiopoda* and *Syringosoma*, have a rather distinctive habitus, but one can find little of real consequence for a generic characterization. *Cylindrophasia* has distinctive female genitalia (Fig. 7), but it would not be difficult to regard the structure as an unusually extreme development of some other genus. It seems indeed to be an intermediate step toward the stout piercer, such as found in *Acaulona* (fig. 6). The male genitalia of *Tapajosia* are quite similar to those of *Cylindrophasia*, differing only in having the median process of the fused anal forceps extremely slender. Both have a cylindrical body, and the two may be synonymous. The female of *Tapajosia* is unknown to me. *Platyphasia* is distinctive in the male sex by having an abrupt right-angled bend in the median process of the anal forceps, as viewed in profile.

Acaulona tehuantepeca Townsend (Smithsonian Misc. Coll. 51: 130. 1908) from the holotype in the U. S. National Museum, is not an *Acaulona* but belongs here. The female genitalia agree with those of *Cylindrophasia*, and *tehuantepeca* is thus referred to that genus on present information.

Dallasimyia Blanchard (Rev. Argentina Ent. **2**: 7. 1944) is not included in the key; it may be near *Cylindrophasia*, but it may also fall with the several concepts at the end of the key (*Homogenia* et al.).

Genus **Homogenia** Van der Wulp

Homogenia Van der Wulp, Tijdschr. Ent. **35**: 184. 1892.
Euomogenia Townsend, Smithsonian Misc. Coll. **51**: 132. 1908.

The relatively few specimens before me, with the broad wings typical of the genus, are all males, and one can suspect that the females may be narrow-winged and presently classified elsewhere. Even the broad wing of the male may not be a constant character, for a male from Argentina with typical genitalia, open apical cell, and broad front, has only a moderately wide wing.

Euomogenia Townsend is a synonym in my opinion; the anal angle is folded under in the type of the genotype, *E. lacteata*, so that the wing appears narrower, and the apical cell is closed at the margin of the wing. A later species, *E. dysderci* Townsend, has a very broad wing with apical cell widely open. I refer both species to *Homogenia*.

Euomogenia dysderci Townsend, Revista Ent. **7**: 317. 1937. Lectotype male, here designated, Campinas, Brazil. Bears the name label and a red label "Type Ht. ♂," by Townsend.

Acaulona Complex

The genera that fall in this complex are extremely difficult to separate satisfactorily, yet there are a few features of the female genitalia that indicate some valid distinctions.

Genera **Xanthomelanopsis** and **Urucurymyia** Townsend

Xanthomelanopsis Townsend, Ins. Insc. Menstr. **4**: 126. 1917.
Urucurymyia Townsend, Revista Ent. **4**: 206. 1934.

These two genera, separated from others in the complex by the stronger chaetotaxy, have quite a different habitus from each other, and the different female genitalia also suggest that they are indeed distinct. As often the case in this tribe, however, it is difficult to find good generic characters. The peculiar appearance of the end of the abdomen in the two available females of *Urucurymyia*, giving an "urn-shaped" appearance (Townsend), may possibly be a distortion that is not necessarily typical. The narrow frontalia of the genotype of *Xanthomelanopsis*, *X. peruanus* Townsend, seems quite distinct, for the frontal stripe at its narrowest is only 1.6–1.9 times the parafrontal directly opposite, whereas in *Urucurymyia* the frontal stripe is approximately four times the parafrontal. However, a species of *Xanthomelanopsis* from Mexico is intermediate (proportion nearly three times), and that distinction is therefore weakened. The femae genitalia of *Xanthomelanopsis peruanus* are similar to the figure for *Melanorophasia* (cf. Fig. 2), though the cerci are nearly quadrate and the eighth sternite is short and inconspicuous.

It is perhaps worthy of special mention that *Xanthomelanopsis* is far removed generically from *Xanthomelanodes*, despite the similarity of name and the fact that the genotype of *Xanthomelanopsis* was originally described as *Xanthomelanodes*. The resemblance is only one of general habitus and common tribal characteristics.

Genus **Melanorophasia** Townsend

Melanorophasia minuscula Townsend

Melanorophasia minuscula Townsend, Revista Ent. **4**: 205. 1934. (Urucurytuba, Brazil; "3 ♂♂, 2 ♀♀".)

When the type series was examined for the purpose of selecting a lectotype, the writer at once noted that the abdomen of the so-called males did not have the usual appearance of males of this tribe, and it was suspected that all specimens in the type series were actually females. Dissection proved this to be the case. What was even more surprising, however, was that *two* different species of females were involved. The three "males" of Townsend have distinctly different genitalia from the two females, besides which the former have entirely black legs, whereas the latter have the hind tibia basally and all femora toward the base yellow. A further difference is that the "males" have a full complement of dorsocentral bristles, whereas the females have a reduced number.

The lectotype of *M. minuscula* Townsend is the female, Urucurytuba, Rio Tapajós, Brazil, April 13 (Townsend), labelled by Townsend as "Ht ♂," and so designated in his *Manual of myiology* **7**: 22. 1938. Paratopotypes: 2 ♀♀, April 4 and 11. Female genitalia as figured (Fig. 2).

The other two specimens from the original type series, which do not seem to be congeneric with *M. minuscula* as here restricted, are left unnamed for the present. Until much more material is available and both sexes known throughout the tribe, and accordingly a generic classification can be better worked out, it would add nothing to describe these and guess at their generic position.

Regarding the genotype of *Melanorophasia*, it might be argued that in a case of this sort the genus is based on a composite species, and a later author is free to select either of the components as genotype. In my view, the genotype is automatically the named or monobasic species as finally restricted by a subsequent author. To be absolutely sure, in the present case, I hereby state that the genotype is *M. minuscula* as restricted above to the lectotype female.

The above actions were necessary to clear the nomenclature of the genus. Whether *Melanorophasia* deserves recognition at all, either as a genus or as a subgenus, is another matter and one upon which there is not sufficient information for judgment.

Genus **Euacaulona** Townsend

Euacaulona Townsend, Smithsonian Misc. Coll. **51**: 131. 1908.

The combination of shape of the squamae, distinct median marginal bristles, and type of male genitalia suggest that this may be a good genus, but material is limited. I have before me only the holotype of *E. sumichrasti* Townsend and two males of another species. Three females that key to this genus have genitalia unlike anything that I have seen in this tribe, and if they prove to be *Euacaulona*, their distinctness will be another argument in favor of recognition. These females are apparently not conspecific with any of the known males, however, and accordingly I cannot be sure of their position until I have males to associate with them, or known females of *Euacaulona* with which to compare.

It would also not be at all impossible that *Euacaulona* is merely based on males of *Acaulona* that are extreme in the bristling on the abdomen and in the width of the squamae.

Genus **Itaxanthomelana** Townsend

Itaxanthomelana Townsend, Rev. Mus. Paulista **15**: 214. 1927.

This genus cannot be keyed out in Townsend (Manual of myiology **3**: 50. 1936) because, contrary to the statement in his couplet 5 and again in the Manual (vol. 7, p. 21), there are no distinct median marginal bristles on the first abdominal segment, and the following two segments have median marginals and not a row of marginals. This is true in both sexes.

If the dorsocentral bristles were not considered significant, the presence of median marginals and the type of both male and female genitalia would key it to *Xanthomelanopsis*, but these two are quite distinct in general habitus. The female genitalia are approximately like those figured for *Melanorophasia* (cf. Fig. 2), the cerci somewhat broader and subquadrate and the eighth sternite broader and shorter. Despite the similarity of name, *Itaxanthomelana* is nearer to *Acaulona* than to *Xanthomelana*.

One specimen before me from Itaquaquecetuba, São Paulo, Brazil, was reared from *Dysdercus*.

Genus **Forcipophasia** Townsend

Forcipophasia Townsend, Revista Ent. **5**: 216. 1935. (Brazil).

This genus was described from a single female having "hypopygium forcepslike." If I interpret the description correctly, however, this is the same type of genitalia found in *Acaulona* (Fig. 6), and the suspicion is strong that *Forcipophasia* may be merely the female of species of *Acaulona*, perhaps based on a specimen in which the genitalia were especially protruding and distinct. Without knowledge of the type, I cannot place it.

Genus **Acaulona** Van der Wulp

Acaulona Van der Wulp, Biologia Centr.-Amer., Zool., Dipt., **2**: 4. 1888.

Acaulona s. str. has the female eighth sternite modified as a strong, black, rather large and conspicuous, piercing sternotheca, strongly recurved so that in profile the distal half is at right angles to the basal portion, deeply grooved above and ending acutely between the approximated tips of the anal cerci (Fig. 6); anal cerci narrow, somewhat elongated, with their apices approximated forcepslike, and approaching or overhanging the seventh sternite so that as seen in profile the cerci and the seventh sternite also appear forcepslike. This is the characteristic form of the female genitalia as found in *A. brasiliana*, *A. peruviana*, *A. erythropyga*, n. sp., and in Mexican material determined by Townsend as *A. costata* Van der Wulp. This type of genitalia seems to be an intermediate step to the phasiine type with strong piercer found in such genera as *Hyalomya*, *Alophorella*, and *Phasiomyia*.

For those who may be tempted by the admittedly close similarity of habitus and general morphology to synonymize some of the other genera of this complex under the older *Acaulona*, it may be noted that *Xanthomelanopsis*, *Melanorophasia s. str.*, and *Itaxanthomelana* have quite a different type of female genitalia, with broad, flat, platelike cerci and the eighth sternite thin, flat, apically rounded and not recurved (Fig. 2). *Urucurymyia* and *Melanorophasia* (atypical part) are slightly different from the last three genera, but are certainly much closer to them than to *Acaulona*. The female of *Euacaulona* is not known to me. Since the type of genitalia found in *Xanthomelanopsis* et al. indicates that the eggs are laid on the body of the host rather than inserted as by *Acaulona*, this difference in reproductive habit suggests that the "*Acaulona* complex" of this paper is not a natural grouping. However, with so many points still unknown from lack of reared material, positively associated sexes, etc., it seems futile to revise further at this time. If the present arrangement proves useful in aiding identification, or in avoiding misidentifications, it will have served its immediate purpose.

Acaulona brasiliana Townsend

Acaulona Townsend, Revista Ent. **7**: 316. 1937. (Campinas, São Paulo, Brazil; parasite of *Dysdercus*.)

The abdomen, as Townsend clearly indicated, is characteristically marked, being mainly dark yellow with a median dorsal row of more or less distinct brown to blackish triangles, the apices directed cephalad. The species is close to *A. peruviana* and it is difficult to find concrete differences. In the series of the two before me, *brasiliana* averages slightly larger, and females are usually darker, though some females have entirely yellowish abdomen. The frontal stripe is slightly wider, two to three times the width of the parafrontal.

Five paratypes (4 ♂♂, 1 ♀) are before me, as well as about two dozen specimens from São Paulo, Brazil, and Bompland (Misiones Territory), Chaco, and Santiago del Estero, Argentina, all reared from *Dysdercus*.

Acaulona peruviana Townsend

Acaulona peruviana Townsend, Est. Exp. Agr. Soc. Nac. Agraria (Lima, Peru), Bol. 1: fig. 3 and p. 7. 1928.

Species with pale habitus, predominantly yellow; scutellum chiefly yellow, usually only narrowly infuscated basally; abdomen mainly yellow with a narrow median brown to blackish stripe on the dorsum, widening slightly on the posterior margin of each tergite beyond the first to form a subtriangular spot, a pattern more pronounced in the female than in the male; tergites 4 and 5 of male conspicuously pollinose, the others more or less shining; in female the fifth tergite polished, fourth large and pollinose, and some pollen on middle of segments one to three, decreasing anteriorly; all coxae yellow; hind femora yellow on basal third to two-thirds, mid on basal fourth to half, fore narrowly yellow at base if at all, legs darker in females than in males.

Parafrontalia relatively broad, and frontalia correspondingly narrow, compared with other species, the relative width of frontalia to parafrontalia across apex of former 1.7 to 1.75 times in the males and 1.8 to 2.2 in the females; female genitalia approximately as figured for *A. brasiliana* (cf. Fig. 6).

Length, 4 to 6.5 mm.

Neotype, male, "Tmb R. [Río Tambo, Peru], 31.V Fls. Euphorbia." Neallotype, same data, May 30. Neoparatypes: 11 (8 ♂♂, 3 ♀♀), same data, May 29, 30, 31; 1 ♀, Sullana, Peru, February 17, 1912; 1 ♀, Chincha, Peru, April 5, "Fls. Euphorbia"; 1 ♀, Zomate, Peru, November 18, "Fls. Telanthera sp."; 1 ♀, Cañada Zamán, Peru, February 14, 1912, "Fls. Ph. flava"; 1 ♀, "Peru"; 1 ♂, Chapairá, Peru, May 21, 1911 (all collected C. H. T. Townsend). The Neallotype bears Townsend's own determination label as "*Acaulona peruviana* TT ♀."

Type, U. S. N. M. no. 60133.

It is essential to fix the name of this species because it is an important parasite of *Dysdercus* in Peru, and attempts have been made to introduce it elsewhere. Townsend never published a formal description of it, but the name was nevertheless validated in connection with the full-page figure published by Townsend in the Boletin cited above. Additional information published at that time located the species in the coastal valleys of Peru as a parasite of *Dysdercus*.

Recent attempts to recover the species after its introduction into Puerto Rico in 1941 and 1942 have so far been negative, though a new and apparently native species has been discovered (see *A. erythropyga*). It is possible that *Acaulona* spp. are host specific, or if not strictly so, at least the Puerto Rican species of *Dysdercus* may be too distantly related to the Peruvian species for the parasites to transfer. There are no species of *Dysdercus* common to Peru and Puerto Rico, according to my colleague Dr. R. I. Sailer.

Neotype designation is not yet recognized by the International Rules, and there will probably be considerable opposition. Certainly the practice is open to abuse, and to merit recognition some clear standards should be insisted upon and rigidly adhered to. If the designation of holotypes and lectotypes has any value and reason for being, much the same value and reason seem to apply also to the designation of neotypes. The major difference is that for neotypes a much graver responsibility rests with the taxonomist who presumes to select a standard of reference (neotype) to replace the original standard for the species (holotype, or by subsequent action, lectotype).

It is my conviction that a neotype should be required to satisfy all of the following requirements, as far as possible: (1) Agreement with the original description, with any redescriptions of the holotype, and with any known figures, photographs or notes on the type; (2) recognition of and agreement with a previous published restriction, or with the oldest if there are several, even though the restriction was not accompanied by a lectotype or neotype designation in a present-day sense; (3) topotypic material, to the extent that the locality is known, and also in the same stratum for paleontological material; (4) for neozoology, the same time of year, same sex, and same host plant or animal as the original, if any or all of these are known; and (5) neotype deposited in the same collection as the original, or in whatever collection or institution the original collection is presently located. In other words, a neotype must and should duplicate the original conditions as nearly as possible.

It would usually be impossible to find an author's original but nontypical material, or perhaps even other material determined by him as the species in question, and thus it would be impracticable to insist on these requirements, but if such material existed, it would certainly be highly desirable and appropriate to utilize that as a neotype series.

The neotype series selected above for *Acaulona peruviana* fulfills all of the above requirements. Of particular importance is the fact that the present series is composed of specimens collected and identified by Townsend himself, and quite possibly intended to be the type series, but for some reason left undescribed in a formal way.

Acaulona tehuantepeca Townsend

Acaulona tehuantepeca Townsend, Smithsonian Misc. Coll. **51**: 130. 1908. (Mexico.)

The type of this species, a female, has short, flattened cilia on the hind tibia and hence will fall in the *Trichopoda* complex rather than in *Acaulona*. Even if the evidence of the flattened cilia is disregarded or overlooked, the species still cannot be placed in *Acaulona*, for the female genitalia are like those of *Cylindrophasia*, to which genus the species has been referred elsewhere in this paper.

Acaulona erythropyga, n. sp.

♂, ♀. A typical *Acaulona*, agreeing with generic diagnosis of Townsend (Manual of Myiology 7: 9, 1938) except in darker color, narrower frontalia, and slightly developed abdominal macrochaetae.

Predominantly blackish, in contrast to the yellow to orange habitus of other known species. *Head* with occiput, frontalia chiefly, and antenna black, tip of palpus infuscated, face and cheek yellow with whitish pollen, and parafrontal black in ground color but whitish to pale yellow pollinose. *Thorax* black with whitish-gray pollen, that on mesonotum outlining the usual pattern of three broad black stripes. *Abdomen* chiefly black, in the female tergites 4 and 5 and the hypopygium bright reddish yellow and strongly contrasting with the rest of the abdomen, in the male these tergites black dorsally and sometimes laterally but usually more or less reddish at least on the extreme sides of tergites, male hypopygium reddish. *Legs* black; claws brown with black tips; pulvilli yellow. *Wing* lightly infuscated throughout, slightly darker on anterior (costal) two-fifths; squama white; halter light yellow.

Width of front at vertex 0.31–0.35 times the width of head; width of frontalia just above antennal bases 2–2.2 times the width of a parafrontal at the same level; third antennal segment slightly longer than the second, as 5:4; sternopleural bristles two, with a weak third in some specimens; marginal bristles on abdominal segments slightly developed, with a pair of widely separated median marginals that are weakly distinct, more so in males than in females; apical cell of wing closed at margin or very narrowly open.

Genitalia: Characteristic *Acaulona* type, the female approximately as figured for *A. brasiliana* (Fig. 6); anal forceps of male with straight, slightly tapered median process.

Length, 5–6 mm.

Holotype, male, Guayanilla, Puerto Rico (W. Gaud; reared from *Dysdercus andreae* (L.), P.R. No. 2578). Allotype, and 12 paratypes (7 ♂♂, 5 ♀♀), same data. "Emerged November 26 to January 25 in R.[earing] Cage 78, which contained numerous host adults and nymphs from fruits and twigs of *Thespesia populnea* along Road 36 at Km. 4.2, near where *Acaulona peruviana* Tns. and *Hyalomya chilensis* Macq. had been liberated in 1941."

Other paratypes (all Puerto Rico): 2 (♂, ♀), Guayanilla, September 21, 1945 (H. K. Plank); 1 ♂, Guayanilla (Gaud), emerged August 11, 1949, from *D. andreae*; 2 (♂, ♀), Guanajibo, near Mayagüez, August 5, 1947, reared from *Dysdercus sanguinarius* Stål; (3 ♂♂, 3 ♀♀)*, Guayanilla (Gaud), emerged September 26–30, 1949 from *D. andreae*; 1 ♀*, Guayanilla (Gaud), emerged September 26, 1949 from *D. andreae*; 2 ♂♂*, Guayanilla (Gaud), emerged November 9 and 28, 1949 from *D. andreae*; 4 (2 ♂♂, 2 ♀♀)*, Guayanilla (Plank), emerged December 22, 1949–January 16, 1950 from *D. andreae*.[2]

Type, U. S. N. M. No. 60134. Paratypes will also be deposited in the British Museum (Nat. Hist.), American Museum of Natural History, and H. J. Reinhard collection.

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[2] Specimens marked with asterisk were reared from hosts collected as noted for the topotypic series.

ENTOMOLOGY.—Sigmactenus, *a new genus of flea from the Philippines.*[1] Robert Traub, Major, MSC.[2] (Communicated by C. W. Sabrosky.)

The Chicago Natural History Museum Expedition to the Philippines, 1946–1947, which operated under the direction of Harry Hoogstraal, collected a most interesting flea, which is here described as a new genus.

Family Leptopsyllidae

Subfamily Pectinocteninae

Sigmactenus, n. gen.

Near *Pectinoctenus* Wagner, but with upper end of comb of head distant from antennal groove and curved backwards; labial palpi extending much below apex of maxillary palpi; frontal tubercle absent; first segment of female antenna shorter than club.

Caput fractum. Upper end of head comb relatively near the anterior margin of head; with an interspace between apices of upper spines and antennal groove, in female this space is as broad as these spines are long, shorter in male. Vestigial eye moved far towards top of head, along with comb; nearer to antennal groove than is the tip of the upper spine. In female, upper spine farther from anterior margin of head than second or third by virtue of translucent base; less so in male; the comb somewhat resembling the letter S (hence the generic name). The area above the comb (frons) different in structure from the area anterior to the comb (clypeus). Frons with a horizontal row of six bristles; below the row two larger ones between the anterior three bristles or between second and fourth bristles; the row continued downwards as a submarginal clypeal row of thin bristles. Immediately in front of the comb a downward row of two bristles, one at level of midpoint of comb. Internal in-

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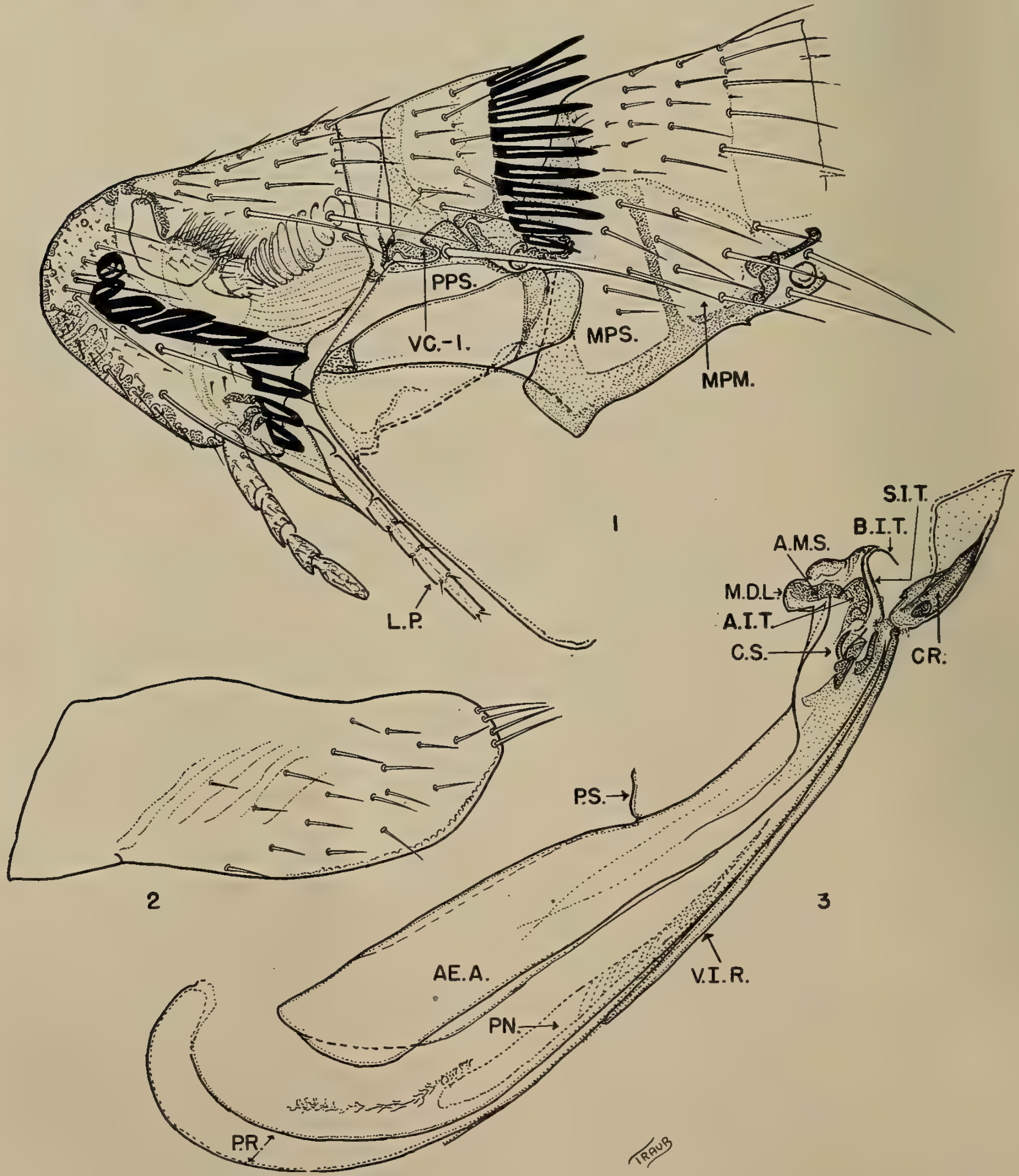
[1] Published under the auspices of the Surgeon General, U. S. Army, who does not necessarily assume responsibility for the professional opinions expressed by the author. Received September 12, 1950.

[2] From the Army Medical Service Research and Graduate School, Washington, D. C.

crassations of upper part of clypeal area extending nearly to comb or somewhat beyond comb. Postantennal area with three rows of bristles. Pedicel with bristles short, at most with only one bristle reaching beyond apex of club. Antennal groove not extending into propleuron. Labial palpi reaching to three-fourths or four-fifths of forecoxae. First vinculum received in sinus of prosternosome. Pronotal comb not extending below the spiracle; separated from the prosternosome by a marginal lobe of the notum. Dorsolateral tibial bristles forming a comb as in *Leptopsylla.* Typical abdominal segments with apical teeth and with two rows of bristles. Male with three antepygidial bristles; female with four. Male eighth tergum large; eighth sternum well-developed. Aedeagal crochets large, apical, articulated, recalling *Leptopsylla.* Third apodemal rod arising from ninth sternum.

Genotype: *Sigmactenus werneri,* n. sp.

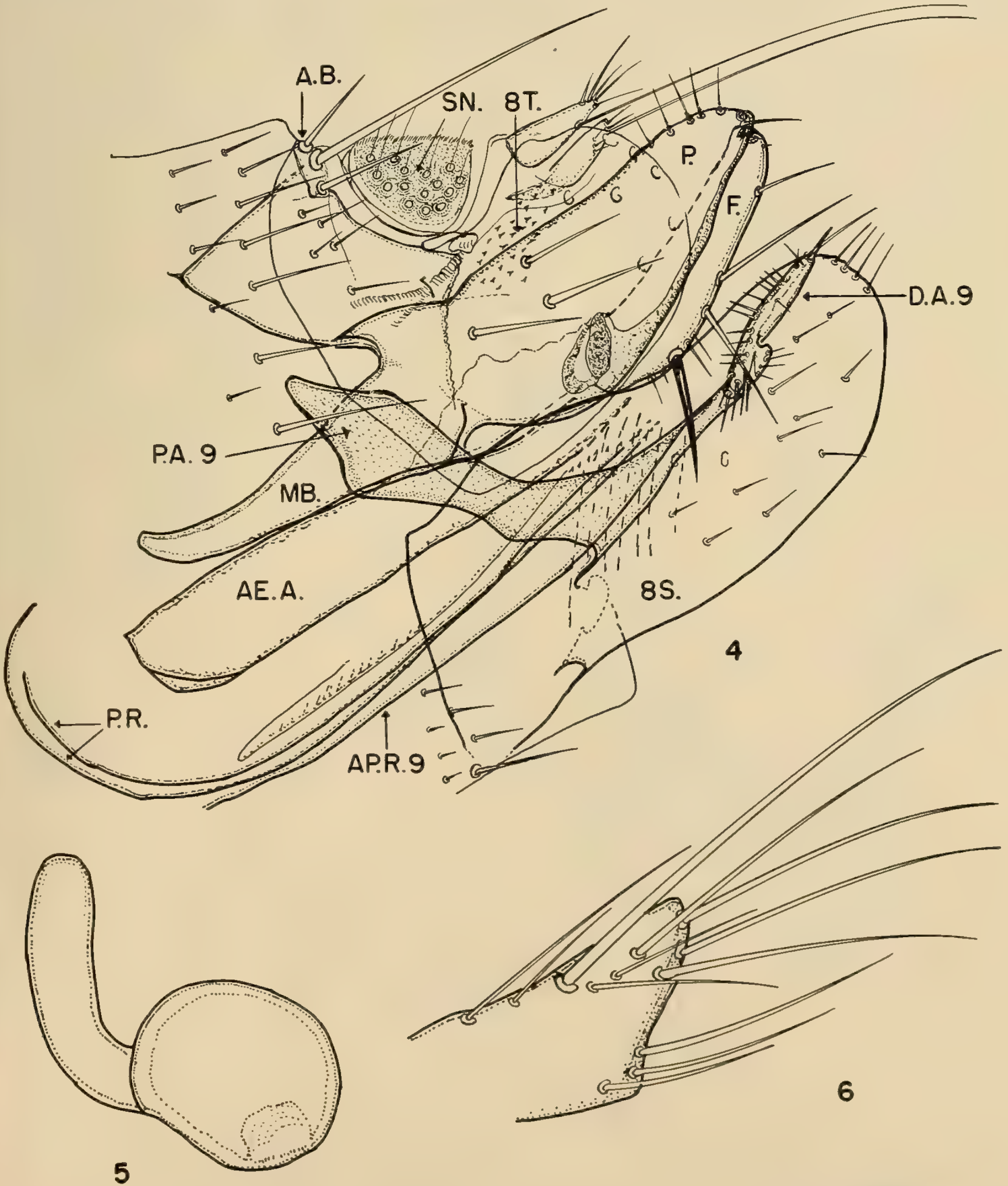


FIGS. 1–3.—*Sigmactenus werneri* n. gen., n. sp.: 1, Head and part of thorax, male; 2, eighth sternum, male; 3, aedeagus.

Sigmactenus werneri, n. sp.

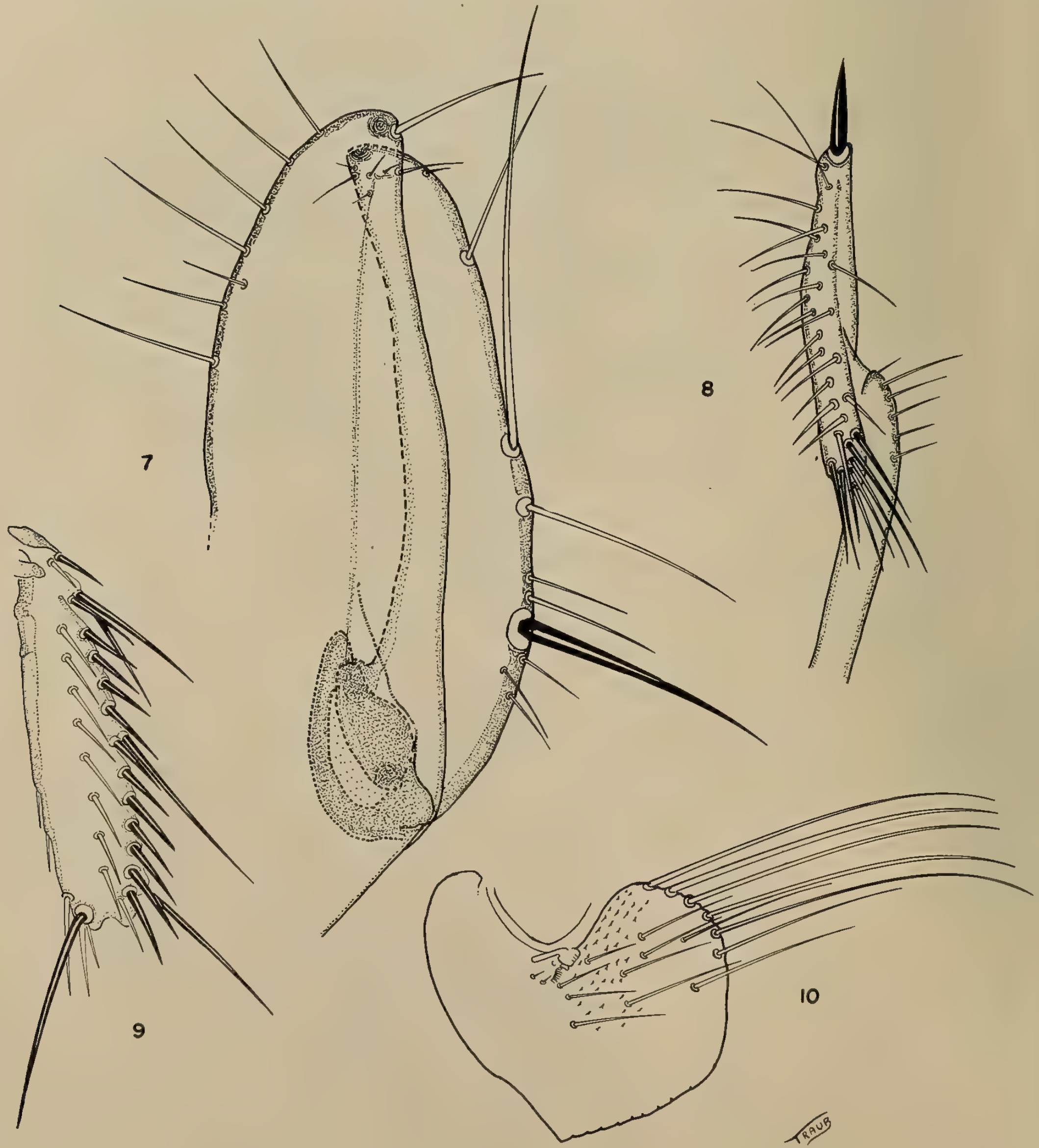
Figs. 1–14

Types.—Holotype male and allotype female ex *Podogymnura truei* (a shrew). Philippine Islands, Mindanao, Davao Province, east slope of Mount McKinley, elev. 6,300 feet, coll. H. Hoogstraal, September 10, 1946, (R.T. #6524). Deposited in Chicago Natural History Museum. One paratype male with same data in author's collection. Two paratype females with same data but 12 September (R.T. #6525). Four females ex *Rattus*, loc. cit. but elev. 6,200 feet, September 28, 1946, coll. M. Celestino for the C.N.H.M. Philippines Expedition (R.T. #6528). Paratype females in U. S. National Museum and British Museum (Tring).

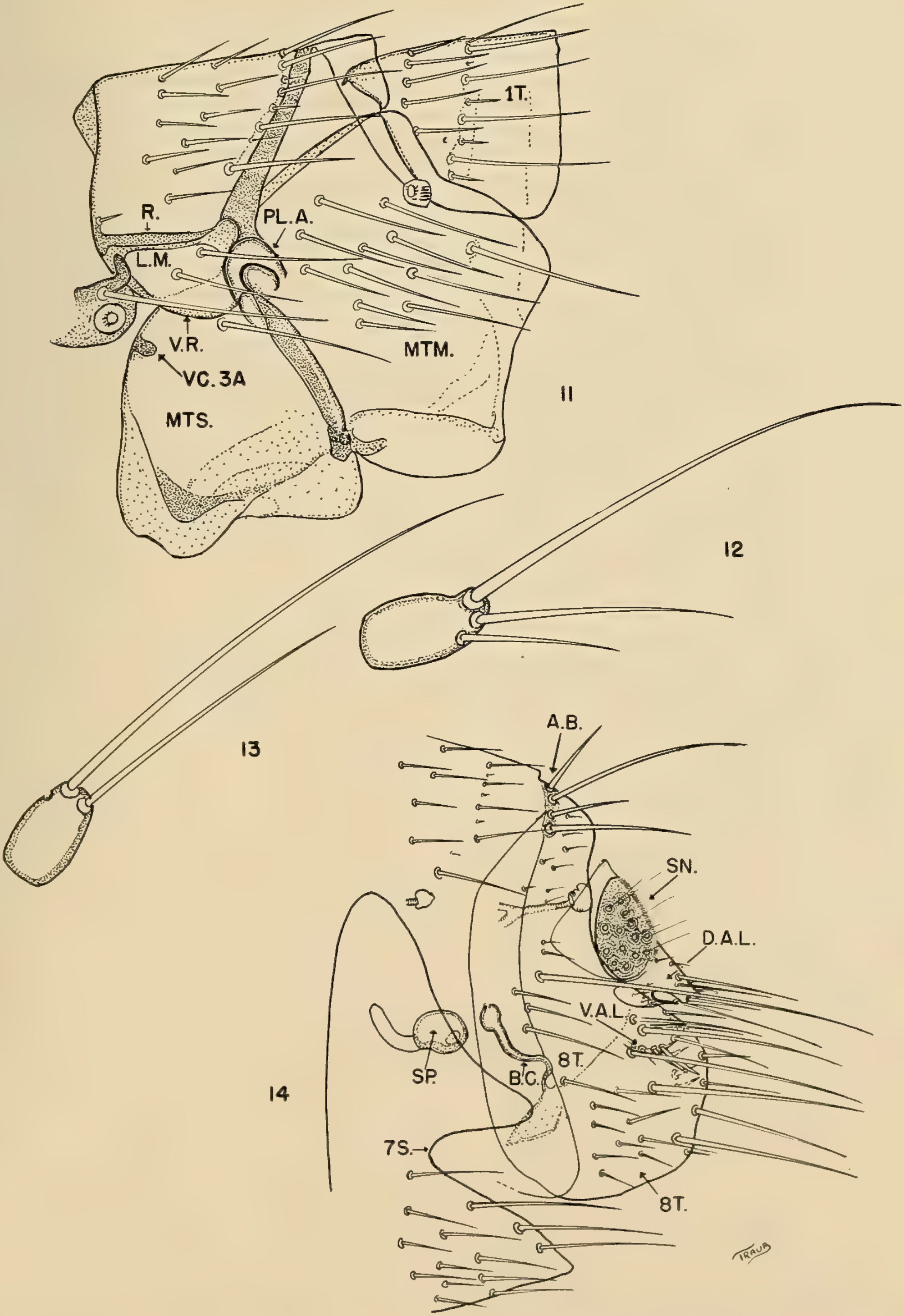


Figs. 4–6.—*Sigmactenus werneri* n. gen., n. sp.: 4, Modified abdominal segments, male; 5, spermatheca; 6, ventral anal lobe, female.

Description.—MALE AND FEMALE, HEAD (Fig. 1): Submarginal clypeal row of six to eight small thin bristles, excluding the much smaller bristles at level of top of comb of head. Upper long bristle below frons row of six inserted at level of upper part of first ctenidial spine; lower bristle longer, inserted at level of ventral margin of this spine. A long bristle about halfway between uppermost and lowermost spines of comb, but inserted near comb; another large bristle almost directly below this but near margin of head. What appears to be a setal pore inserted near base of second spine. This pore present in all specimens, but no bristle visible in any. Spines of comb variable in number, ranging from 7 to 10, 8 and 9 being the most frequent number. The holotype has eight on one side and nine on the other; two paratypes also have one more spine on one side than the other. Maxillary lobe extending to near apex of second segment of



FIGS. 7–10.—*Sigmactenus werneri* n. gen., n. sp.: 7, Immovable process of clasper, and exopodite; 8, distal arm of ninth sternum; 9, protibia; 10, eighth tergum, male.



FIGS. 11–14—*Sigmactenus werneri* n. gen., n. sp.: 11, Metathorax and part of abdomen, male; 12, anal stylet (variation); 13, typical anal stylet; 14, modified abdominal segments, female.

five-segmented labial palpi. As seen when resting in antennal groove, apical half of male first antennal segment with scattered small thin lateral bristles and with a dense tuft of dorsal and marginal and submarginal bristles; this tuft absent in female. Male with bristles of second antennal segment all short, none even reaching halfway length of club; female with one bristle of this segment reaching beyond apex of club. Postantennal region with bristles on each side 4(5)-4-5-6, the first row irregular; the penultimate of last row the longest.

Thorax: Pronotum with two rows of bristles and a comb of about eleven long thin spines on a side. Lowest bristle of pronotal row overlapping proepisternum (*PPS.*) very long. Mesonotum with three or four rows of bristles, the first one or two incomplete. Mesepisternum (*MPS.*) with eight bristles arranged 3-3-2. Metanotum with three rows of bristles. Metanotal flange with two apical teeth on each side. Lateral metanotal area (fig. 11, *L.M.*) distinct; with dorsal ridge (*R.*) well sclerotized, ventral ridge (*V.R.*) less so; with two bristles. Pleural arch (*PL.A.*) at junction of metanotal ridge and pleural ridge, strongly convex, well-developed. Metepisternum (*MTS.*) with one bristle, near dorsocaudal angle. Metepimere (*MTM.*) with 11 or 12 (rarely 10) bristles on each side. Metanotal flange with a small apical tooth on each side.

Legs: Metacoxa lacking a patch of mesal spinelets or thin bristles; with one lateral bristle above insertion of trochanter. All femora with one marginal subapical bristle. Protibia (Fig. 9) with nine dorsolateral bristles (including three from the paired bristles) short and subequal, forming a distinct comb. Mesotibia and metatibia with eleven such bristles in comb. In each case the comb preceded by a sparser row of thinner bristles. Measurements of tibiae and segments of tarsi (petiolate base deleted) shown in microns:

Leg	Tibia	Tarsal segments				
		1	2	3	4	5
Pro-	179	69	72	61	47	100
Meso-	288	173	126	85	58	100
Meta-	357	321	178	118	63	100

Not only are the legs very long, particularly the hind legs, but they are narrow: ratio of metatibial length to breadth is more than 4 to 1; similar ratio in metatarsal segment I is 7 to 1. None of tarsal bristles reaching beyond apex of following segment. Fifth tarsal segments of all legs with four lateral plantar bristles and a basal pair displaced ventrally to near midline.

Abdomen: Typical abdominal segments with second row of bristles extending below spiracles. With small subdorsal teeth on posterior margins of first few segments; in male these teeth arranged (on each side) 2-2-2-1-(1); in female 2-2-(1)-1. Basal sternum with one ventromarginal bristle. Typical sterna with three bristles on a side in male, four in female. Male with middle antepygidial bristle about thrice the length of the others (Fig. 4, *A.B.*); in female, the second and fourth antepygidial bristles two to three times as long as the other (Fig. 14, *A.B.*).

Modified abdominal segments, male (Fig. 4): Eighth tergum (*8T.* and Fig. 10) extending as far caudad as middle of process of clasper, as far ventrad as base of clasper; with six very long dorsocaudal bristles, the last somewhat shorter than the others; with about nine or ten median or submedian bristles, none ventral; spiculose caudad and dorsad of spiracle. Eighth sternum (*8S.* and Fig. 2) extending as far distad as apex of ninth sternum and as far dorsad as base of clasper; dorsal margin biconvex; caudal margin subrounded; ventral margin proximally shallowly concave, distally convex; apex with a marginal row of four bristles; with about seventeen or eighteen scattered lateral bristles, none truly marginal.

Immovable process of clasper (*P.* and Fig. 7) subconical; portion distad of an imaginary line immediately above insertion of exopodite twice as long as broad; anterior margin slightly sinuate; apex almost rounded; posterior margin almost straight and with a bristle at apex; with five or six bristles on apical third of anterior margin. Exopodite (*F.* and Fig. 7) long and narrow, suggesting *Foxella* Wagner, 1929, slightly more than four times as long as broad at base; anterior margin shallowly concave; posterior margin subparallel with anterior for most of its length. Posterior margin of exopodite with a long stout bristle or subspiniform at proximal third; three small thin bristles below the subspiniform and two just above it; with a very long bristle near midpoint; a shorter bristle below this, but distad of those near subspiniform, and equal in size to another bristle at apical third. Exopodite with five to seven short thin apical or subapical bristles, some mesal.

Manubrium (*MB.*) about 3½ times as long as broad at base; dorsal and ventral margins fairly straight; dorsal margin, in the main, making an angle of about 40° with ventral margin; apex slightly upturned, not pointed.

Proximal arm of ninth sternum (*P.A. 9*) markedly expanded at apical fourth, the ventral margin particularly convex here; narrowing rapidly towards apex, which is narrowed; remainder of ventral margin shallowly biconcave, the proximal concavity the smaller; remainder of dorsal margin evenly convex. Distal arm of ninth sternum (*D.A. 9* and Fig. 8) much narrower than proximal arm, only about one-third as broad as narrower portions of proximal arm; more than seven or eight times as long as broad; divided into a basal and apical half, the latter bearing a conspicuous apical spiniform, a fringe of 7 or 8 basal stout heavy bristles and about 17 bristles on anterior (morphologically dorsal) margin or on dorsal portion, the most apical two the longest; basal half with about six small bristles near apex of posterior margin.

Aedeagal apodeme (*AE.A.* and fig. 3) slightly longer than aedeagus proper, but the characteristic apical sclerites crowded in the small end chamber. Proximal spur (*P.S.*) present. Crescent sclerite (*C.S.*) convex, identifying position of obscured sclerites of apodemal strut. Median dorsal lobe (*M.D.L.*) short, convoluted, associated with a lateral sinuate sclerite (*A.M.S.*) on each side. Sclerotized inner tube (*S.I.T.*) nearly vertical, slightly sinuate. With a sclerotized narrow band of the inner tube (*B.I.T.*) extending distad of apex of sclerotized sheath of inner tube. Armature of inner tube (*A.I.T.*) represented as an irregular somewhat bilobed sclerotized structure along dorsal border of *S.I.T.* Crochets (*CR.*) very large, consisting of a ventral subfusiform, apically acuminate, well sclerotized portion and a larger cleaver-shaped, lateral, lightly sclerotized portion; lateral lobes inapparent, but no specimen available for dissection. Ventral intramural rod (*V.I.R.*) present.

Sensilium (Fig. 4, *SN.*) flat, longer than broad, with about 17 pits visible on a side. Dorsal lobe of proctiger with about four subapical bristles. Ventral lobe of proctiger with about four apical and one or two subapical longish bristles and three or four small subapical bristles.

FEMALE (Fig. 14): Seventh sternum (*7S.*) caudally biconcave, the sinus between the lobes deep; the lobes slightly longer than broad at base, somewhat narrowed or even pointed apically; the dorsal lobe in some specimens almost as long as ventral lobe, at times the two sides of one specimen differ in this respect. Ventral lobe of seventh sternum with three or four long dorsomarginal bristles, the lowest near the apex, and ten to twelve smaller, more proximal bristles, one of these bristles near base of sinus sometimes as long as marginal ones. Eighth tergum (*8T.*) with many bristles, commencing with two dorsal rows (one incomplete) of small bristles above spiracle; with four well-developed submedian bristles, that below tenth segment large; with a row of four large bristles ranging from ventral anal lobe to ventral margin of segment; with 9 to 13 smaller bristles in irregular rows preceding these large bristles; ventral half of caudal margin with four or five bristles, the longest one at shallow sinus of segment; with three or four mesal curved bristles near ventral anal lobe. Dorsal anal lobe of proctiger (*D.A.L.*) with two or three subapical longish bristles and about four small ones forming an apical fringe, with five or six tiny hairs at anteroventral angle. Anal stylet (Fig. 13) not quite twice as long as broad; dorsal and ventral margins somewhat convex; with two long apical bristles, one very long; with an indication or vestige of base of a subapical dorsal bristle; one specimen with an additional well-developed subapical bristle (Fig. 12). Ventral anal lobe (*V.A.L.* and Fig. 6) with dorsal margin shallowly concave; caudal margin sinuate; with three dorsomarginal bristles, the last very long; caudal margin with three bristles near dorsal angle and three near ventral; with three median bristles in dorsocaudal angle. Spermatheca (*SP.* and Fig. 5) with head longer than broad; dorsal margin strongly convex, ventral margin shallowly concave, anterior and posterior margins rounded; tail narrow, longer than head. In allotype (drawn) the spermatheca may be somewhat distorted in mounting; in other specimens, particularly in series R.T. #6528 (cf. below), the tail is slightly recurved over the head. Bursa copulatrix (*B.C.*) well-developed, vermiform except for dilated head.

Remarks.—This is a highly variable species; as can be seen from the description, even the two sides of an individual may vary in such usually established characters as number of genal spines and shape of female seventh sternum. The series from *Rattus* show slight differences in chaetotaxy and in the seventh sternum, but these differences cannot properly be evaluated without additional specimens.

The species is named for Floyd Werner, entomologist, who served under Harry Hoogstraal on the Chicago Natural History Museum Philippines Expedition and who has collected some very interesting ectoparasites.

I wish to thank Dr. Karl Jordan, J. H. E. Hopkins, and F. G. A. M. Smit, of the British Museum, for reviewing the manuscript.

LIST OF ABBREVIATIONS

A.B.	Antepygidial bristle.
AE.A.	Aedeagal apodeme.
A.I.T.	Armature of inner tube of aedeagus.
A.M.S.	Apical or apicomedian sclerites of aedeagus.
AP.R.9	Apodemal rod of ninth sternum.
B.I.T.	Narrow band of inner tube extending distad of apex of sclerotized inner tube.
B.C.	Bursa copulatrix
CR.	Crochet of aedeagus.
C.S.	Crescent sclerite.
D.A.L.	Dorsal anal lobe.
D.A.9	Distal arm of ninth sternum.
F.	Exopodite or movable finger.
L.M.	Lateral metanotal area.
L.P.	Labial palpi.
MB.	Manubrium.
M.D.L.	Median dorsal lobe.
MPM.	Mesepimere.
MPS.	Mesepisternum.
MTM.	Metepimere.
MTS.	Metepisternum.
P.	Immovable process of clasper.
P.A.9	Proximal arm of ninth sternum.
PL.A.	Pleural arch of metathorax.
PN.	Penis.
PPS.	Proepisternum.
P.R.	Penis rods.
P.S.	Proximal spur of aedeagus.
R.	Dorsal ridge of lateral metanotal area.
S.I.T.	Sclerotized inner tube.
SN.	Sensilium.
SP.	Spermatheca.
V.A.L.	Ventral anal lobe of proctiger.
VC.1	First vinculum.
VC.3A.	Accessory link below third vinculum.
V.I.R.	Ventral intramural rod.
V.R.	Ventral ridge.
7S.	Seventh sternum.
8S.	Eighth sternum.
1T.	First tergum.
8T.	Eighth tergum.

ZOOLOGY.—*A new species of* Terebripora *from the Pacific* (*Bryozoa Ctenostomata*).[1]

John D. Soule, Allan Hancock Foundation, University of Southern California. (Communicated by Waldo L. Schmitt.)

As early as 1920 Canu and Bassler lamented the lack of information available concerning the anatomical details of burrowing bryozoans, but until the publication by Marcus in 1938 of "Bryozoarios Perfuradores de Conchas" the anatomy and ctenostomatous affinities of the burrowing Bryozoa remained completely unknown. In this work Marcus discussed and figured the anatomy of *Terebripora ramosa* d'Orbigny, 1847, and *Spathipora sertum* Fischer, 1866. No further work pertaining to the anatomy of this type of burrowing Bryozoa appeared until 1946, when Silen published the results of his research on two new families of burrowing Bryozoa, the Penetrantiidae and the Immergentiidae. The following year, 1947, Silen adequately pointed out the futility of basing the specific classification of burrowing Bryozoa entirely upon their zoarial tracings made in the shells of mollusks. With regard to this, Silen pointed out how some of the species previously assigned to the genus *Terebripora* merely on the basis of shell tracings could as easily be assigned to *Immergentia* and that some of the *Spathipora* may well be *Penetrantia*. In so far as superficial external appearances are concerned, determination of the genera and the species is hopeless. On the basis of shell markings confirmed by anatomical studies, the burrowing Bryozoa until now fell into two groups: the *Terebripora-Immergentia* type and the *Spathipora-Penetrantia* type. *Terebripora ramosa* d'Orbigny readily fits into this pattern.

With the publication of Silen's work it therefore becomes necessary to amend the description of the genus *Terebripora* d'Orbigny, 1847, to include basic anatomical details which will serve to distinguish this genus from the genera *Spathipora*, *Immergentia*, and *Penetrantia*, respectively.

Genus **Terebripora** d'Orbigny, 1847

Zoaria stolonate, consisting of primary stolons joined to the zoids by secondary stolons, the point of union with the zoids being nearly midway between the distal and proximal extremities, but

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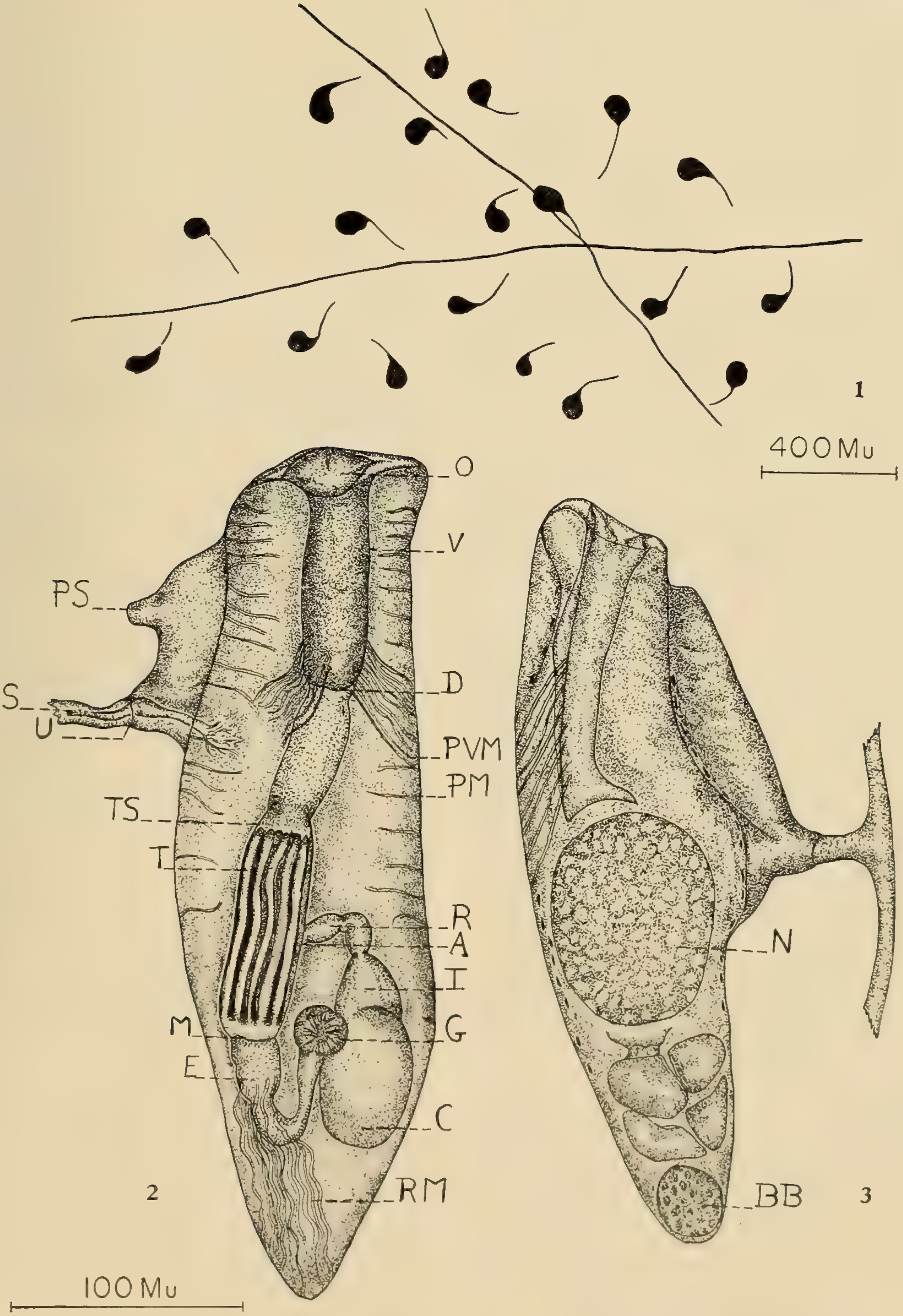
[1] Contribution from the Allan Hancock Foundation. Received August 16, 1950.



Figs. 1–3.—*Terebripora comma*, n. sp.: 1, Shell surface, showing a portion of a zoarium and the characteristic shape of the apertures, dried specimen; 2, same, showing anatomy of the autozoid; 3, same, showing anatomy of the kenozoid. (A-anus; BB-brown body; C-caecum; D-diaphragm; E-esophagus; G-gizzard; I-intestine; M-mouth; N-embryo; O-orifice; PM-parietal muscle; PS-pseudo stolon; PVM-parieto-vaginales muscle; R-rectum; RM-retractor muscle; S-stolon; T-tentacle; TS-tentacle sheath; U-septum; V-vestibule.) Drawings by Dorothy F. Soule.

always closer to the distal end. Polypide with a prominent gizzard. The genotype is *Terebripora ramosa* d'Orbigny, 1847.

KEY TO THE GENERA

1. Zoaria with primary stolons connected to zoids by short secondary stolons, entering near distal end.
   a. Zoids operculated, gonozoid present (Penetrantiidae) *Penetrantia*
   b. Zoids not operculated, no gonozoid (Terebriporidae) *Terebripora*
2. Zoaria lacking secondary stolons.
   a. Stolonal point of attachment at distal extremity (Immergentiidae) *Immergentia*
   b. Stolonal point of attachment at proximal extremity (Terebriporidae) *Spathipora*

Actually there is considerable doubt as to the soundness of including the genus *Spathipora* in the family Terebriporidae because of its wide anatomical differences. However, until the opportunity to examine the zoids of the *Spathipora* presents itself, I believe it best to let the matter rest.

The exact dates of publication of the various installments of d'Orbigny's "Voyage dans l'Amerique Meridionale" have long been a controversial subject. Fortunately, the library of the Allan Hancock Foundation retains the original covers of the installments bound separately. The date 1847 for the genus *Terebripora* was selected following an examination of the original blue wrapper (cover) which contained among other items the zoophyte section and bears the printed date 1847, 89th "livraison."

KEY TO THE SPECIES WITH KNOWN ANATOMY

Autozoid with 12 tentacles..........*T. ramosa*
Autozoid with 8 tentacles...........*T. comma*

Terebripora comma, n. sp.

Diagnosis.—Successive zoids are alternately placed to the right and to the left of the primary stolon at the end of a short secondary stolon. From the primary stolons occasional thin branches extend upward to the shell surface where they emerge and appear as minute round dots. Autozoid elongate, tapering to a rounded point at the proximal end, occasionally with a pseudostolonal connective point distal to the actual secondary stolonal junction. Tentacle number of the autozoid is 8. Embryos develop in numerous kenozoids.

Description.—In *Terebripora comma* is found the first variation from the usual *Terebripora-Immergentia* type of surface tracings as delineated in the introductory passage. The zoarium in its original state prior to decalcification of the mollusk shell has a very striking resemblance to the surface tracings of *Spathipora sertum* Fischer, 1866, as figured by the original author and later by Marcus. So close is this resemblance that if the anatomy were unknown it could be identified as Fischer's species with no risk of contradiction. There is also a remarkable resemblance to the original figure of *Spathipora longirima* Canu and Bassler, 1923. The openings of the immersed zoids are close without being crowded (Fig. 1). When a trace of the filiform stolon is in evidence on the shell surface the openings are found in alternate arrangement to the right and to the left of the stolonal path and have a distinct comma-like appearance.

In a zoarium removed by decalcification of the shell, the zoids are found to be of two types, the autozoids and the kenozoids. These zoids are alternately arranged along the thin threadlike primary stolon by means of very short lateral secondary stolons, each having a septum at the junction point where the stolon meets the zoid. These secondary stolons enter the zoids about midway between the distal and proximal extremities, but always nearer to the distal. Occasionally on both types of zoids will be found a short extension that appears to be a second or pseudostolonal connective point, but is without attachment to a secondary stolon and is located immediately distal to the true secondary stolon. The primary stolons, with a diameter ranging between 11.5 μ and 14 μ have additional septa separated by stolonal intervals of varying lengths. From the primary stolons an occasional thin branch occurs, extending upward to open as a minute circular dot on the shell surface.

Anatomically, the autozoids are typical of the usual ctenostomatous type (Fig. 2). In the polypide is found a prominent globular gizzard. In length the autozoids range from 320 μ to 350 μ and in width from 57 μ to 80 μ. The tentacles are short and in serial sections were found to be 8 in number. The autozoids are elongate, with the distal aperture bluntly square and the proximal portion terminating in a tapering rounded point. None of the distinct spherical brown bodies so much in evidence in the *Penetrantia* and the *Immergentia* were found.

The numerous kenozoids, formerly functional autozoids now modified for reproduction, have a prominent large oval embryo of uniform diameter measuring 69 μ at maturity (Fig. 3). The kenozoids vary in length from 299 μ to 334 μ and in width from 75 μ to 80 μ. Structures that may be incipient brown bodies were found in a few of the kenozoids in the proximal tip below the degenerate polypide.

Terebripora comma differs from *T. ramosa* d'Orbigny in the following respects: (1) The tentacle number of *T. comma* has 8 tentacles, *T. ramosa* 12, *fide* Marcus; (2) *T. comma* has pseudostolonal connective points; (3) the zoaria of *T. comma* does not conform to the usual *Terebripora-Immergentia* surface pattern as is found in *T. ramosa.*

Holotype.—AHF no. 53.

Repository.—Allan Hancock Foundation, University of Southern California, Los Angeles, Calif.

Type locality.—Accession no. 403 T 112, southwest of Newport, Calif. trawl 112, 18 fathoms, June 16, 1915. In the shell of a dead *Polinices draconis.*

Additional distribution.—Hancock station no. 1937–50, 1 mile northwest of the west end of Anacapa Island, Calif., lat. 34° 01′ 32″ N., long. 119° 27′ 30″ W.; depth 38-43 fathoms; bottom sandy; March 24, 1950; in dead shell of *Epitonium* sp.?

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ZOOLOGY.—*A new* Orconectes *from the Pontchartrain watershed in Louisiana and Mississippi (Decapoda: Astacidae).*[1] George Henry Penn, Tulane University of Louisiana. (Communicated by Fenner A. Chace, Jr.)

The new crawfish described here apparently is limited in distribution to the coolwater, sand- and gravel-bottomed creeks and rivers that make up the Lake Pontchartrain watershed in southeastern Louisiana and adjoining parts of Mississippi. I take great pleasure in naming this new species in honor of my close friend and authority on North American crawfishes, Dr. Horton H. Hobbs, Jr., of the University of Virginia.

Orconectes (Orconectes) hobbsi, n. sp.

Diagnosis.—Rostrum with prominent lateral spines, upper surface deeply concave, no median carina. Areola very narrow, its length averaging 24 times its width. Thoracic region of cephalothorax about 28 percent of the total length of the cephalothorax. Male with hooks on ischiopodites of third pereiopods only. First pleopod of form I male terminating in two long, setiform, deeply split rami: central projection corneous and recurved at right angles to the shaft; mesial process troughlike just proximad of the apex, recurved at about 90° angle to shaft. Annulus ventralis of female immovable, surface contours and sinus as in Fig. 8; may be either right- or left-handed.

Holotypic male, form I.—Body subovate, not depressed (Figs. 1, 2). Abdomen narrower than cephalothorax. Width of cephalothorax at widest point slightly greater than depth at same point.

Areola very narrow (24 times longer than width), without any punctations in narrowest part; cephalic portion of cephalothorax about 2.6 times as long as areola; length of areola 28 percent of total length of cephalothorax.

Rostrum with prominent lateral spines; widest at base, margins raised, more or less straight and converging; no median carina. Acumen long, acute.

Postorbital ridges prominent, terminating cephalad in acute corneous spines. Branchiostegal spine small, but prominent. Cephalic groove interrupted in vicinity of cephalolateral spines, the latter very prominently developed.

Cephalic region of telson with two spines in each caudolateral angle, the more lateral spine about twice the length of the mesial one.

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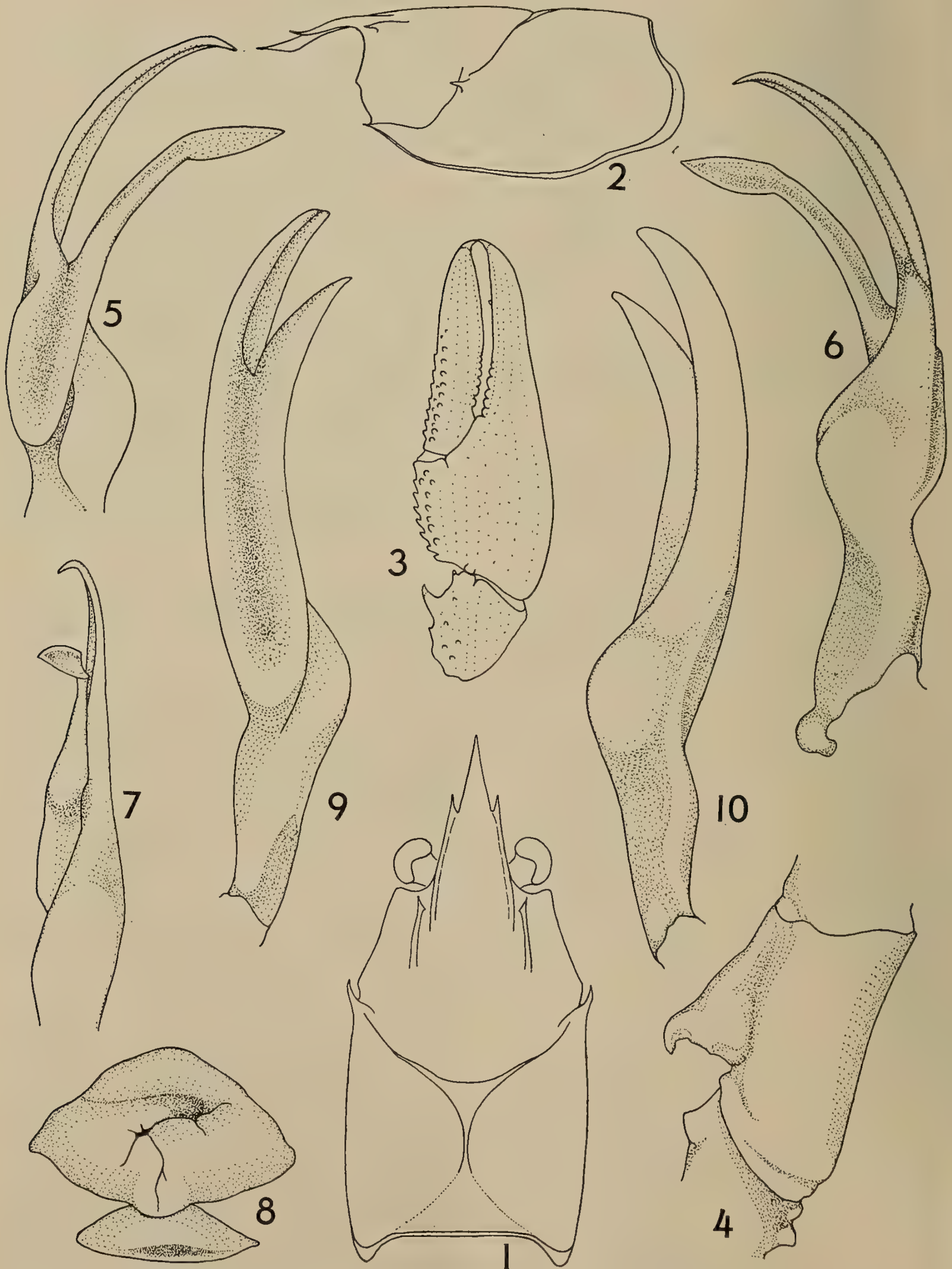
[1] Aided by a grant from the University Council on Research of the Tulane University of Louisiana. Received June 23, 1950.



Figs. 1–10.—*Orconectes* (*Orconectes*) *hobbsi*, n. sp.: 1, Dorsal view of cephalothorax of holotype; 2, lateral view of cephalothorax of holotype; 3, upper surface of chela of holotype; 4, hook on ischiopodite of third pereiopod of holotype; 5, mesial view of first pleopod of holotype; 6, lateral view of first pleopod of holotype; 7, caudal view of first pleopod of holotype; 8, annulus ventralis of allotype; 9, mesial view of first pleopod of morphotypic male, form II; 10, lateral view of first pleopod of morphotypic male, form II.

Antennules of usual form.

Antennae broken, approximately equal to total length of crawfish on other specimens. Antennal scales extending slightly beyond apex of rostrum; lateral margin straight or nearly so, swollen, terminating in a strong spine; lamellar portion narrow; greatest width of scale about one-third of total length of scale.

Chela somewhat depressed; palm inflated; inconspicuous setigerous punctations present over most of chela; inner margin of palm with several irregular rows of small tubercles (Fig. 3). Both fingers terminating in short corneous tips bent toward each other. Small tubercles on basal parts of opposable margins of fingers. With medium length tuft of hairs at base of immovable finger. In life both fingers dark blue over basal three-fourths, followed by a narrow white band and bright red apex.

Hooks on ischiopodites of third pereiopods only; hooks prominent, greater than half the diameter of the base of the ischiopodite, apex recurved (Fig. 4).

First pleopod reaching anterior margin of coxopodite of third pereiopod when abdomen is flexed. Apex terminating in two distinct rami which are separated for most of their lengths (Figs. 5–7). Central projection corneous, long, setiform and recurved caudad at a 90° angle to the shaft. Mesial process swollen just proximad of the tip and trough-like, recurved caudad at about a 90° angle to the shaft.

Allotypic female.—Quite similar to the holotype in most respects. Annulus ventralis immovable, subspindle-shaped, with greatest length in transverse axis. Sinus originates near cephalodextral margin, extends irregularly sinistrad across annulus beyond midline, and turns abruptly caudodextrad back to the midline, then caudad on an irregular, somewhat zigzag course to the midcaudal margin of the annulus (Fig. 8).

Morphotypic male, form II.—Differs only slightly from the holotype. Hooks on ischiopodites of third pereiopods much reduced. First pair of pleopods longer, reaching to anterior margin of coxopodite of second pereiopod when abdomen is flexed; without corneous tips on terminal rami; rami separated for less than one-fourth of their lengths (Figs. 9, 10). Central projection stout, slightly excavated along caudo-mesial margin, tip recurved caudad at less than a 45° angle to the shaft. Mesial process shorter than central projection, stout, tip recurved caudad at less than a 45° angle to the shaft.

Measurements.—HOLOTYPIC MALE: Cephalothorax, height 9.0, width 10.0, length (on mid-dorsal line) 21.0 mm; areola, width at narrowest point 0.25, length 6.0 mm; rostrum, width at base 2.8, length 6.6 mm; abdomen, length to tip of telson 23.0 mm; right chela, length of inner margin of palm 4.2, greatest width of palm 5.6, thickness of palm 3.9, length of outer margin of hand 14.7, length of movable finger 9.0 mm; antennal scale, length of lateral margin 5.6, greatest width 1.9 mm. ALLOTYPIC FEMALE: Cephalothorax, height 9.1, width 10.5, length on mid-dorsal line 22.5 mm; areola, width at narrowest point 0.25, length 5.95 mm; rostrum, width at base 2.8, length 8.1 mm; abdomen, length to tip of telson 24.0 mm; right chela, length of inner margin of palm 4.2, greatest width of palm 5.6, thickness of palm 3.5, length of outer margin of hand 14.4, length of movable finger 8.4 mm.

Type locality.—The holotype and allotype were collected on November 7, 1948, in the headwater creek of Bayou Lacombe at St. Tammany (6 miles north of Lacombe on Louisiana State Highway 187), St. Tammany Parish, La. This is a shallow, spring-fed, sand-bottomed creek about 20 feet wide flowing through cutover longleaf pine flats which are only slightly above sea level (alt. 10 feet). The banks are eroded and shaded by mixed hardwoods and pines. Vegetation is scarce in the water, but drifts of fallen branches and leaves behind sandbars make abundant hiding places for crawfishes and other aquatic invertebrates.

The morphotypic male, form II, was collected July 10, 1948, in the Tchefuncte River, 4 miles west of Covington, St. Tammany Parish, La This is a creek slightly larger than but essentially similar to the one at the type locality.

Disposition of types.—The holotypic male, the allotypic female, and the morphotypic male, form II, are deposited in the United States National Museum, nos. 90952, 90953, and 90954, respectively. From the paratypic series, one male, form I, one male, form II, and one female are deposited in the Museum of Comparative Zoology, and similar series are deposited in the collections of the Academy of Natural Sciences of Philadelphia, the University of Michigan Museum of Zoology, the collection of Dr. Horton H. Hobbs, Jr., of the University of Virginia, and the American Museum of Natural History. One male, form I, 6 males, form II, 19 juvenile males, 13 females, and 13 juvenile females are retained in the Tulane University collections.

Specimens examined.—Sixty-six paratypes of *Orconectes hobbsi* in addition to the three types have been examined from the Lake Pontchartrain watershed in Louisiana and Mississippi. Arranged by parishes (Louisiana) and counties (Mississippi) these records and disposition of the specimens are as follows: *LOUISIANA:* EAST FELICIANA: Comite River, 1 mile west of Clinton, III-28-49, F. R. Cagle (TU 990); LIVINGSTON: Amite River, 2 miles south of Weiss, VII-3-48, G. H. Penn and M. H. Penn (U. M. M. Z.); ST. HELENA: Amite River, 1 mile west of Darlington, VII-3-48, G. H. Penn and M. H. Penn (TU 574); Tickfaw River, 1 mile northeast of Liverpool, VIII-13-48, G. H. Penn and M. H. Penn (TU 775); ST. TAMMANY: Tchefuncte River, 4 miles west of Covington, VII-10-48, A. Hagan (morphotype, U. S. N. M.; A. N. S.; A. M. N. H.); Slidell; VI-3-37, P. Viosca and H. B. Chase (TU P.624) headwaters of Bayou Lacombe at St. Tammany, VI-13-37, P. Viosca and G. H. Penn (TU P-334; A. N. S.); same locality, I-9-38, P. Viosca and G. H. Penn (A. N. S.; U. M. M. Z.); same locality, VII-10-48, A. Hagan (TU 620, M. C. Z.); same locality, XI-7-48, L. L. Ellis (holotype and allotype, U. S. N. M.; TU 852; M. C. Z.); same locality, XI-1-49, G. H. Penn (H. H. Hobbs); same locality, VI-2-50, G. H. Penn and E. W. Smith (TU 1974). *MISSISSIPPI:* AMITE: Beaver Creek, 2 miles east of Gloster, VII-4-48, G. H. Penn and M. H. Penn (TU 581); PIKE: Bogue Chitto River, 12 miles east of McComb, VII-5-48, G. H. Penn and M. H. Penn (TU 586).

Relationships.—*Orconectes hobbsi* is clearly a member of the *Virilis* section of the genus on the basis of the long, setiform, deeply split, recurved rami. Its affinities within the section are not entirely clear at present. The structure of the first pair of pleopods of the form I male and of the rostrum makes it appear closest to *O. palmeri* (Faxon) and *O. creolanus* (Creaser), but it differs from these species in having an open areola, though this is extremely narrow.

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MATHEMATICS.—*Rings associated with the rings of endomorphisms of finite groups.*[1] JOHN F. CLARK, JR., George Washington University. (Communicated by F. E. Johnston.)

In recent years the study of rings of endomorphisms has been given increased attention as a method for the study of abstract rings. It is the purpose of this paper to develop methods to determine the rings of endomorphisms and all other associated transformation rings of certain finite groups.

Group, ring, and field.—A *group* G is a set of elements $a, b, c, \cdots$, which is closed with respect to the associative operation $+$, includes an identity element 0, and contains an inverse element $-a$ for each element a. A group is abelian if $a + b = b + a$ for every pair of elements in G. A *ring* R is an abelian group which is closed under a binary operation of multiplication which is associative, and distributive with respect to addition. An *integral domain* is a commutative ring, with a unity element 1 and no divisors of zero. A *field* F is an integral domain in which division always exists. It may be defined more simply as a commutative division ring.

Classes of finite groups.—If the number of elements in a group is finite, then that group is said to be a *finite* group and the number of elements is the *order* of the group Henceforth the term "group" will denote "finite group" unless otherwise stated. A group G is said to be *cyclic* if all its elements $a, b, c, \cdots$ may be obtained by taking the additive powers of some appropriately chosen element. If this is not possible, the group is said to be *noncyclic*.

Rings of transformations.—Consider any arbitrary group G, together with its collection $T_{(G)}$ of single-valued transformations of G onto a subset of G. Any two transformations A and B are regarded as equal if the images xA and xB are identical for all elements x in G. Then convert $T_{(G)}$ into an algebraic system by introducing two operations. The *sum* of any two transformations A and B in $T_{(G)}$ is defined by its effect on any element x in G as follows:

$$x(A + B) = xA + xB$$

In the same manner, the *product* of A and B is defined as follows:

$$x(AB) = (xA)B$$

The following facts regarding the system $T_{(G)}$ result as a consequence of the above operations:

(1) T is a group relative to addition. The identity transformation 0 is defined by the equation $x0 = 0$. The inverse of A equals the negative of A, and is defined by the equation $x(-A) = -xA$.

(2) T possesses the following characteristics of a group with respect to multiplication: (a) $(AB)C = A(BC)$, (b) $A(B + C) = AB + AC$, (c) The unity transformation 1 is defined by $x1 = x$.

Therefore, as Jacobson has shown, the system $T_{(G)}$ satisfies all the conditions required of a ring except for the commutative addition relation:

$$A + B = B + A \tag{1}$$

and the second distributive law:

$$(B + C)A = BA + CA \tag{2}$$

The problem of the determination of the

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[1] Received September 5, 1950.

transformation rings of G has thus been resolved into the determination of which subsets of T are closed with respect to both addition and multiplication, and also satisfy equations (1) and (2). Obviously, if G is abelian then equation (1) is automatically satisfied.

As an example, consider the cyclic group of order 3. Its elements may be represented by 0, 1, and 2. The rule of combination is ordinary addition, modulo 3. In this case, $T_{(G)}$ contains 3^3 or 27 terms of the form $\left\{\begin{matrix} 0 & 1 & 2 \\ a & b & c \end{matrix}\right\}$, in which a, b, and c each equals 0, 1, or 2. In the identity transformation (0), a, b, and c each equals the element 0; while in the unity transformation (1), a equals 0, b equals 1, and c equals 2. Each addition or multiplication table of the 27 elements of $T_{(G)}$ contains $(27)^2$ or 729 resultant sums or products. The difficulties inherent in the task of computing and inspecting these tables in order to select the rings of transformations of even so trivial a group are obvious.

A more logical method of attack consists of an analysis of the general transformation of the cyclic group of order 3, $T_g = \left\{\begin{matrix} 0 & 1 & 2 \\ a & b & c \end{matrix}\right\}$. In equation (2), substitute $A = T_g$ and $B = C = 0$, the identity transformation:

$$\left[\left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 0 & 0 \end{matrix}\right\} + \left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 0 & 0 \end{matrix}\right\}\right]\left\{\begin{matrix} 0 & 1 & 2 \\ a & b & c \end{matrix}\right\} = \left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 0 & 0 \end{matrix}\right\}\left\{\begin{matrix} 0 & 1 & 2 \\ a & b & c \end{matrix}\right\} + \left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 0 & 0 \end{matrix}\right\}\left\{\begin{matrix} 0 & 1 & 2 \\ a & b & c \end{matrix}\right\}$$

$$\left\{\begin{matrix} 0 & 1 & 2 \\ a & a & a \end{matrix}\right\} = \left\{\begin{matrix} 0 & 1 & 2 \\ a & a & a \end{matrix}\right\} + \left\{\begin{matrix} 0 & 1 & 2 \\ a & a & a \end{matrix}\right\}$$

Therefore:

$$a = a + a$$

Since 0 is the only element of G which will fulfill the last equation, a must be 0 in any transformation which may be included in the same ring as the transformation 0, as equation (2) applies to every element of a given ring. Since the transformation 0 must be in each ring of transformations as the additive identity, $T_g = \left\{\begin{matrix} 0 & 1 & 2 \\ 0 & b & c \end{matrix}\right\}$ must be the form of each transformation in every ring of transformations $R_{(T)}$ derived from the cyclic group of order 3. In order to determine which transformations of the form $\left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 1 & c \end{matrix}\right\}$ may be included in any $R_{(T)}$, in equation (2) let $A = B = C = \left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 1 & c \end{matrix}\right\}$:

$$\left[\left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 1 & c \end{matrix}\right\} + \left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 1 & c \end{matrix}\right\}\right]\left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 1 & c \end{matrix}\right\} = \left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 1 & c \end{matrix}\right\}\left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 1 & c \end{matrix}\right\} + \left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 1 & c \end{matrix}\right\}\left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 1 & c \end{matrix}\right\}$$

$$\left\{\begin{matrix} 0 & 1 & 2 \\ 0 & c & - \end{matrix}\right\} = \left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 2 & - \end{matrix}\right\}$$

Therefore:

$$c = 2$$

In the same manner, if $b = 2$, $c = 1$; if $c = 1$, $b = 2$; and if $c = 2$, $b = 1$.

All transformations except 0, 1, and $A = \left\{\begin{matrix} 0 & 1 & 2 \\ 0 & 2 & 1 \end{matrix}\right\}$ have thus been eliminated from further consideration as elements of any ring of transformations, since these remaining three $T_{(G)}$ are the only transformations capable of satisfying equation (2) as applied above. It has not yet been proven, however, that any of these transformations are elements of any ring. The addition and multiplication tables, respectively, for these three transformations are as follows:

	0	1	A
0	0	1	A
1	1	A	0
A	A	0	1

	0	1	A
0	0	0	0
1	0	1	A
A	0	A	1

By inspection, these elements are commutative and the set of elements is closed with respect to both addition and multiplication. Substitution of these elements in equation (2) satisfies the equation with all possible combinations of 0, 1, and A. Therefore, this set of three transformations forms a ring. In addition, it is obvious by inspection that the transformation 0 is also a ring, the only proper subring of the ring of order 3 just discussed, and the only other ring of transformations included in the totality of transformations $T_{(G)}$.

Rings of endomorphisms.—Consider the subset $E_{(G)}$ of $T_{(G)}$ consisting of the endomorphisms of an arbitrary group G. A transformation A of a group is an *endomorphism* if it is a homomorphism of the group into itself. Two groups are *homomorphic* if there exists a one-way correspondence between their elements such that to every element of the first group there corresponds a unique element of the second, but not conversely.

The above definition of an endomorphism may be expressed as follows:

$$(x + y)A = xA + yA \tag{3}$$

for all elements x, y, $\cdots$ in G. From equation (3), if A is in $E_{(G)}$ and B and C are arbitrary elements of $T_{(G)}$, then:

$$(B + C)A = BA + CA$$

Therefore, the elements of E satisfy equation (2). In addition, these elements are obviously closed with respect to the multiplication defined in $T_{(G)}$, since $(x + y)AB = (xA + yA)B = xAB + yAB$.

Thus, the set $E_{(G)}$ satisfies all of the requirements of a ring except the additive closure property and equation (1). If G is commutative these two conditions are satisfied. Consequently if G is an abelian group, the set $E_{(G)}$ forms a ring.

The elements of $E_{(G)}$ may be determined for any specific group such as that of order 3 previously discussed by substituting various elements of G for x and y, and T_g for A in equation (3). If $x = y = 0$, then in T_g, $a = 0$. If $x = y = 1$, then in T_g, $c = b + b$. The only $T_{(G)}$ which fulfil these conditions are 0, 1, and A. These three transformations satisfy equation (3) with any combination of elements of G substituted for x and y. Therefore, $E_{(G)}$: 0, 1, A is the same ring which was previously shown to be the largest ring included as a subset of the totality of transformations $T_{(G)}$ of the cyclic group of order 3.

Transformation rings of cyclic groups of arbitrary order r.—The general cyclic group of order r, when r is any positive integer, may be represented by the integers 0, 1, 2, $\cdots$, $(r - 1)$ where the rule of combination is ordinary addition, modulo r. Its addition table is given in the following table:

ADDITION TABLE OF THE CYCLIC GROUP OF ORDER r

	0	1	2.....	$(r-2)$	$(r-1)$
0	0	1	2.....	$(r-2)$	$(r-1)$
1	1	2	3.....	$(r-1)$	0
2	2	3	4.....	0	1
.	.	.	......	.	.
.	.	.	......	.	.
.	.	.	......	.	.
$(r-1)$	$(r-1)$	0	1.....	$(r-3)$	$(r-2)$

Addition is commutative, and the identity element is 0. The general transformation $T_g = \begin{Bmatrix} 0 & 1 & 2 \cdots & r-2 & r-1 \\ a & b & c \cdots & m & n \end{Bmatrix}$. As was the case with the cyclic group of order 3, the transformation 0 must be in every ring of transformations included in $T_{(G)}$, since it is the additive identity element. So, in equation (2), substitute $A = T_g$ and $B = C = 0$:

$$\left[\begin{Bmatrix} 0\,1\,2\,\cdots \\ 0\,0\,0\,\cdots \end{Bmatrix} + \begin{Bmatrix} 0\,1\,2\cdots \\ 0\,0\,0\cdots \end{Bmatrix}\right]\begin{Bmatrix} 0\,1\,2\cdots \\ a\;b\;c\cdots \end{Bmatrix}$$

$$= \begin{Bmatrix} 0\,1\,2\cdots \\ 0\,0\,0\cdots \end{Bmatrix}\begin{Bmatrix} 0\,1\,2\cdots \\ a\;b\;c\cdots \end{Bmatrix}$$

$$+ \begin{Bmatrix} 0\,1\,2\cdots \\ 0\,0\,0\cdots \end{Bmatrix}\begin{Bmatrix} 0\,1\,2\cdots \\ a\;b\;c\cdots \end{Bmatrix}$$

$$\begin{Bmatrix} 0\,1\,2\cdots \\ a\;a\;a\cdots \end{Bmatrix} = \begin{Bmatrix} 0\,1\,2\cdots \\ a\;a\;a\cdots \end{Bmatrix} + \begin{Bmatrix} 0\,1\,2\cdots \\ a\;a\;a\cdots \end{Bmatrix}$$

Therefore:

$$a = a + a$$

Consequently, $a = 0$ in any transformation of any cyclic group if that $T_{(G)}$ is an element of any ring of transformations.

In equation (2), let $A = B = C = \left[\begin{Bmatrix} 0\,1\,2\,\cdots\, r-2 & r-1 \\ 0\,\mathrm{b}\,\mathrm{c}\,\cdots\, m & n \end{Bmatrix}\right.$, the form of any $T_{(G)}$ in any $R_{(T)}$. Now suppose $b = 1$. Expanding only pertinent terms:

$$\left[\begin{Bmatrix} 0\,1\,2\cdots \\ 0\,1\,c\cdots \end{Bmatrix} + \begin{Bmatrix} 0\,1\,2\cdots \\ 0\,1\,c\cdots \end{Bmatrix}\right]\begin{Bmatrix} 0\,1\,2\cdots \\ 0\,1\,c\cdots \end{Bmatrix}$$

$$= \begin{Bmatrix} 0\,1\,2\cdots \\ 0\,1\,c\cdots \end{Bmatrix}\begin{Bmatrix} 0\,1\,2\cdots \\ 0\,1\,c\cdots \end{Bmatrix}$$

$$+ \begin{Bmatrix} 0\,1\,2\cdots \\ 0\,1\,c\cdots \end{Bmatrix}\begin{Bmatrix} 0\,1\,2\cdots \\ 0\,1\,c\cdots \end{Bmatrix}$$

$$\begin{Bmatrix} 0\,1\,2\cdots \\ 0\;c\;-\cdots \end{Bmatrix} = \begin{Bmatrix} 0\,1\,2\cdots \\ 0\,1\,-\cdots \end{Bmatrix} + \begin{Bmatrix} 0\,1\,2\cdots \\ 0\,1\,-\cdots \end{Bmatrix}$$

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Therefore:

$$c = 1 + 1 = 2$$

Then, let $A = B = \left\{\begin{matrix} 0\ 1\ 2\ 3 \cdots \\ 0\ 1\ 2\ d \cdots \end{matrix}\right\}$ and $C = B + B$, in equation (2). In the same manner as above, solution of equation (2) yields $d = 3$. This procedure may be extended until $A = B = \left\{\begin{matrix} 0\ 1\ 2 \cdots r - 2\ r - 1 \\ 0\ 1\ 2 \cdots r - 2 \quad n \end{matrix}\right\}$ and $C = \overbrace{B + B + \cdots + B}^{r-2}$. Solution of equation (2) yields $n = r - 1$. Therefore, the only transformation in which $b = 1$, and which can be in any ring, is the unity transformation.

In order to determine which other $T_{(G)}$ may be in the same ring as the unity transformation 1, substitute $B = C = 1$ in equation (2):

$$\left[\left\{\begin{matrix}0\ 1\ 2\cdots\\0\ 1\ 2\cdots\end{matrix}\right\} + \left\{\begin{matrix}0\ 1\ 2\cdots\\0\ 1\ 2\cdots\end{matrix}\right\}\right]\left\{\begin{matrix}0\ 1\ 2\cdots\\0\ b\ \ c\cdots\end{matrix}\right\}$$

$$= \left\{\begin{matrix}0\ 1\ 2\cdots\\0\ 1\ 2\cdots\end{matrix}\right\}\left\{\begin{matrix}0\ 1\ 2\cdots\\0\ b\ c\cdots\end{matrix}\right\}$$

$$+ \left\{\begin{matrix}0\ 1\ 2\cdots\\0\ 1\ 2\cdots\end{matrix}\right\}\left\{\begin{matrix}0\ 1\ 2\cdots\\0\ b\ c\cdots\end{matrix}\right\}$$

$$\left\{\begin{matrix}0\ 1\ 2\cdots\\0\ c - \cdots\end{matrix}\right\} = \left\{\begin{matrix}0\ 1\ 2\cdots\\0\ b - \cdots\end{matrix}\right\} + \left\{\begin{matrix}0\ 1\ 2\cdots\\0\ b - \cdots\end{matrix}\right\}$$

Therefore:

$$c = b + b$$

In the same manner, if $B = 1$ and $C = 1 + 1$, then $d = b + b + b$. This process may be continued until, if $B = 1$ and $C = \overbrace{1 + 1 + \cdots + 1}^{r-2}$, then

$$n = \overbrace{b + b + \cdots + b}^{r-1}.$$

It is evident that if b is assigned a value, all of the other elements of the lower row of T_g are uniquely determined. Since b may be assigned values from 0 to $r - 1$, r values in all, there may be a maximum of r transformations in the same ring as the transformation 1.

It should be noted that if $b = 0$, the transformation 0 is obtained; if $b = 1$, the transformation 1 is obtained; and, in general, if $b = \overbrace{1 + \cdots + 1}^{p}$ the transformation $\overbrace{1 + \cdots + 1}^{p}$ is obtained. Of course the r^{th} additive power of the unity transformation of a cyclic group of order r is the zero transformation. Thus, it has been shown that if the unity transformation 1 is in any ring, it is in the ring consisting of the r additive powers of itself, and no other transformations. However, it has not yet been proved that 1 is in any $R_{(T)}$.

Now consider $E_{(G)}$, the ring of endomorphisms of the cyclic group of order r, and a subset of $T_{(G)}$. It is known that E is a ring because the cyclic group of order r is abelian. Since the elements of $E_{(G)}$ must satisfy equation (3) for all combinations of the elements of G, let $A = T_g$, and $x = y = 0$. Equation (3) becomes:

$$(0 + 0)\left\{\begin{matrix}0\ 1\ 2\cdots r - 1\\a\ b\ c\cdots \quad n\end{matrix}\right\}$$

$$= 0\left\{\begin{matrix}0\ 1\ 2\cdots r - 1\\a\ b\ c\cdots \quad n\end{matrix}\right\}$$

$$+ 0\left\{\begin{matrix}0\ 1\ 2\cdots r - 1\\a\ b\ c\cdots \quad n\end{matrix}\right\}$$

$$a = a + a$$

Therefore, $a = 0$ in every endomorphism of G. This conclusion agrees with the previous result that $a = 0$ in any transformation which is an element of any $R_{(T)}$. If $A = T_g$, and $x = y = 1$, equation (3) becomes:

$$(1 + 1)\left\{\begin{matrix}0\ 1\ 2\cdots r - 1\\a\ b\ c\cdots \quad n\end{matrix}\right\}$$

$$= 1\left\{\begin{matrix}0\ 1\ 2\cdots r - 1\\a\ b\ c\cdots \quad n\end{matrix}\right\}$$

$$+ 1\left\{\begin{matrix}0\ 1\ 2\cdots r - 1\\a\ b\ c\cdots \quad n\end{matrix}\right\}$$

$$c = b + b$$

This process may be continued in the same manner until, if $A = T_g$, $x = 1$, and $y = r - 2$, then $n = \overbrace{b + \cdots + b}^{r-1}$.

Therefore, by inspection and comparison with previous results, the ring of endomorphisms of any cyclic group of arbitrary order r must consist of the r additive powers of the transformation 1, since the same conditions must be fulfilled by the elements of $E_{(G)}$ as by the r additive powers of (1), and these r transformations each satisfy equation (3) for any combination of elements in G.

The preceeding properties of the transformations of a cyclic group of order r, when r is any positive integer, may be summarized as follows:

1. If any transformation $T_{(G)}$ is in any ring $R(_T)$, it must be of the form $\left\{\begin{matrix} 0 & 1 & 2 & \cdots & r-1 \\ 0 & b & c & \cdots & n \end{matrix}\right\}$
2. If, in the above $T_{(G)}$, $b = 1$, then if $T_{(G)}$ is in any $R(_T)$ the former must be the unity transformation 1.
3. The only ring which contains the unity transformation is the ring of endomorphisms $E_{(G)}$.
4. $E_{(G)}$ consists of the r additive powers of the unity transformation 1, the transformation 0 being the r^{th} additive power of (1).
5. $E_{(G)}$ isnot a proper subring of any larger ring in $T_{(G)}$.

Transformation rings of cyclic groups of prime order p.—Consider those groups whose order is any prime p. It has been demonstrated that such a group is a cyclic group, and contains no proper subgroup other than that consisting of the identity element alone. Moreover, each element of G_p except the identity element 0 is of order p. From the properties of a cyclic group of arbitrary order, it is known that the p additive powers of the transformation 1 comprise the ring of endomorphisms $E_{(G)}$; that this ring has only one subring $R_{(0)}$, composed of the transformation 0 alone; that the unity transformation 1 is not an element of any ring other than $E_{(G)}$; and that each $T_{(G)}$ in every $R_{(T)}$ is of the form $\left\{\begin{matrix} 0 & 1 & 2 & \cdots & p-1 \\ 0 & b & c & \cdots & n \end{matrix}\right\}$.

In order to determine which transformations (if any) other than those contained in $E(_G)$ may be included in any $R(_T)$, select an arbitrary T_1 not included in $E_{(G)}$. First, suppose in T_1 $b \neq 0$. Any additive power of T_1 is included in the same ring as T_1; and since every element of G_p other than 0 is of order p, in some additive power of T_1, $b = 1$. But if $b = 1$ in some T, then that transformation in order to be in any ring must be the unity transformation 1; and in order for T_1 to be in the same ring as 1, it must be included in $E_{(G)}$, which is contrary to the original hypothesis that T is not included in $E_{(G)}$. Therefore if T_1 is not included in $E_{(G)}$, $b = 0$.

Unless some element in the lower row of T_1 is different from 0, T_1 is the transformation 0, which is included in $E_{(G)}$. Denote such a nonzero element by f. Again, the p additive powers of T_1 must be in the same ring as T_1, and in some such power T_f, $f = 1$. In equation (2), let $A = B = C = T_f$:

$$\left[\left\{\begin{matrix} 0 & 1 & 2 & \cdots & s & \cdots \\ 0 & 0 & c & \cdots & 1 & \cdots \end{matrix}\right\} + \left\{\begin{matrix} 0 & 1 & 2 & \cdots & s & \cdots \\ 0 & 0 & c & \cdots & 1 & \cdots \end{matrix}\right\}\right] \left\{\begin{matrix} 0 & 1 & 2 & \cdots & s & \cdots \\ 0 & 0 & c & \cdots & 1 & \cdots \end{matrix}\right\}$$

$$= \left\{\begin{matrix} 0 & 1 & 2 & \cdots & s & \cdots \\ 0 & 0 & c & \cdots & 1 & \cdots \end{matrix}\right\} \left\{\begin{matrix} 0 & 1 & 2 & \cdots & s & \cdots \\ 0 & 0 & c & \cdots & 1 & \cdots \end{matrix}\right\}$$

$$+ \left\{\begin{matrix} 0 & 1 & 2 & \cdots & s & \cdots \\ 0 & 0 & c & \cdots & 1 & \cdots \end{matrix}\right\} \left\{\begin{matrix} 0 & 1 & 2 & \cdots & s & \cdots \\ 0 & 0 & c & \cdots & 1 & \cdots \end{matrix}\right\}$$

$$\left\{\begin{matrix} 0 & 1 & 2 & \cdots & s & \cdots \\ 0 & 0 & - & \cdots & c & \cdots \end{matrix}\right\} = \left\{\begin{matrix} 0 & 1 & 2 & \cdots & s & \cdots \\ 0 & 0 & - & \cdots & 0 & \cdots \end{matrix}\right\}$$

Therefore:

$$c = 0$$

In the same manner, if $A = B = T_f$, and $C = T_f + T_f$, then $d = 0$. This process may be extended until $A = B = T_f$, and $C = \overbrace{T_f + \cdots + T_f}^{p-2}$, whence $n = 0$. Therefore all elements in the lower row of T_1 must equal 0, which is contrary to hypothesis.

It has thus been proven that if any T_1 of a group of prime order is not an additive power of the transformation 1, then it cannot be an element of any ring of transformations included in $T_{(G)}$, and thus $E_{(G)}$ and $R_{(0)}$ are the only two rings included in the totality of transformations $T_{(G)}$. It should be noted that the ring of endomorphisms of a prime order group is also a field, since multiplication is commutative and division always exists.

Transformation rings of cyclic groups of *order* p^k.—Prime-power groups, or groups of order p^k where p is a prime and k is a positive integer greater than 1, may be either cyclic or noncyclic. This section deals only with cyclic prime-power groups.

The statements given in the preceding section regarding prime order groups may be extended to prime-power groups to some extent. In a prime-power group, all elements are of order p^k except for 0 and the other multiples of p. Therefore, if any element in the lower row of T_g is any non-zero element not divisible by p, then the proofs applicable to the prime order groups apply, and that T_g must either be an element of $E_{(G)}$ or else it is not included in any $R_{(T)}$.

This fact makes the selection of all possible $R_{(T)}$ of a prime-power group considerably simpler. For example, the simplest prime-power group is the cyclic group of order 4, in which $T_g = \left\{\begin{matrix} 0 & 1 & 2 & 3 \\ a & b & c & d \end{matrix}\right\}$. This group has associated with it $4^4 = 256$ different T. Since $a = 0$ in any T which is included in any $R_{(T)}$, only $4^3 = 64$ T remain possibilities for inclusion in any R. Now, if any T in which any element in the lower line is an element of G not divisible by p, namely 1 or 3, may be eliminated from consideration as an element in any $R_{(T)}$ other than $E_{(G)}$, then the possible elements of any ring have been reduced to 2^3 in number, plus those elements of the ring of endomorphisms not included in the above eight possibilities. $E_{(G)}$ consists of 0, 1, $A = 1 + 1 = \left\{\begin{matrix} 0 & 1 & 2 & 3 \\ 0 & 2 & 0 & 2 \end{matrix}\right\}$, and $B = 1 + 1 + 1 = \left\{\begin{matrix} 0 & 1 & 2 & 3 \\ 0 & 3 & 2 & 1 \end{matrix}\right\}$. The six remaining possibilities are:

$$C = \left\{\begin{matrix} 0 & 1 & 2 & 3 \\ 0 & 0 & 0 & 2 \end{matrix}\right\}; \qquad D = \left\{\begin{matrix} 0 & 1 & 2 & 3 \\ 0 & 2 & 0 & 0 \end{matrix}\right\};$$

$$E = \left\{\begin{matrix} 0 & 1 & 2 & 3 \\ 0 & 0 & 2 & 0 \end{matrix}\right\}; \qquad F = \left\{\begin{matrix} 0 & 1 & 2 & 3 \\ 0 & 0 & 2 & 2 \end{matrix}\right\};$$

$$G = \left\{\begin{matrix} 0 & 1 & 2 & 3 \\ 0 & 2 & 2 & 0 \end{matrix}\right\}; \qquad H = \left\{\begin{matrix} 0 & 1 & 2 & 3 \\ 0 & 2 & 2 & 2 \end{matrix}\right\}.$$

Neither 1 nor B is in any $R_{(T)}$ other than $E_{(G)}$, since either transformation, when added to any $T_{(G)}$ other than those in $E_{(G)}$, produces a resultant $T_{(G)}$ which has been proven to be an element of no $R_{(T)}$. E is not an integral domain nor, of course, a field, because it contains a divisor of zero, namely A, since $A \cdot A = 0$. As always, $R_{(0)}$ is a subring of E. It should be noted that there is also another subring of $E_{(G)}$ consisting of 0 and A. In general, any element of a ring of endomorphisms of an order less than that of the group will be an element of a sub-ring of E of the same order as that element.

The addition and multiplication tables for the remaining eight transformations are given in the following tables:

ADDITION TABLE OF TRANSFORMATIONS OF THE CYCLIC GROUP OF ORDER 4

	O	A	C	D	E	F	G	H
O	O	A	C	D	E	F	G	H
A	A	O	D	C	H	G	F	E
C	C	D	O	A	F	E	H	G
D	D	C	A	O	G	H	E	F
E	E	H	F	G	O	C	D	A
F	F	G	E	H	C	O	A	D
G	G	F	H	E	D	A	O	C
H	H	E	G	F	A	D	C	O

MULTIPLICATION TABLE OF TRANSFORMATIONS OF THE CYCLIC GROUP OF ORDER 4

	O	A	C	D	E	F	G	H
O	O	O	O	O	O	O	O	O
A	O	O	O	O	A	A	A	A
C	O	O	O	O	C	C	C	C
D	O	O	O	O	D	D	D	D
E	O	O	O	O	E	E	E	E
F	O	O	O	O	F	F	F	F
G	O	O	O	O	G	G	G	G
H	O	O	O	O	H	H	H	H

By inspection, addition and multiplication are closed, and addition is commutative. Therefore, if equation (2) is universally valid then these elements form a ring. Let B and C of equation (2) equal any element of the above eight, and A of equation (2) equal 0, A, C, or D. Under these conditions, equation (2) becomes $0 = 0 + 0$, because any of the above eight transformations multiplied by 0, A, C, or D equals 0. If A of equation (2) equals E, F, G, or H, equation (2) becomes $(B + C) = B + C$, since any of the above elements multiplied by E, F, G, or H equals the former transformation. Therefore, the transformations 0, A, C, D, E, F, G, and H form a ring R_t. This ring is neither an integral domain nor a field, due to the many divisors of zero which are present.

Again by inspection of the above tables, there are subrings of R_t as follows:

1. 0. This ring is also a subring of $E_{(G)}$, and is an integral domain and a field.
2. 0, A. This ring is also a subring of $E_{(G)}$, but is neither an integral domain nor a field.
3. 0, C. This ring is neither a field nor an integral domain.

4. 0, D. This ring is neither a field nor an integral domain.
5. 0, E. This ring is also a field and an integral domain.
6. 0, F. This ring is also a field and an integral domain.
7. 0, G. This ring is also a field and an integral domain.
8. 0, H. This ring is also a field and an integral domain.
9. 0, A, C, D. This ring is neither a field nor an integral domain.
10. 0, A, E, H. This ring is neither a field nor an integral domain.
11. 0, A, F, G. This ring is neither a field nor an integral domain.
12. 0, C, E, F. This ring is neither a field nor an integral domain.
13. 0, C, G, H. This ring is neither a field nor an integral domain.
14. 0, D, E, G. This ring is neither a field nor an integral domain.
15. 0, D, F, H. This ring is neither a field nor an integral domain.

Transformation rings of cyclic groups of order pq.—Groups of order pq, where p and q are primes, may be either cyclic or non-cyclic. This section deals only with cyclic groups of order pq.

In cyclic groups of order pq, all non-zero elements of G_{pq} are of order pq except for multiples of p and q. Therefore, if any element in the lower row of T_g is any non-zero element not divisible by p or q, then the proofs applicable to the prime order groups apply, and that T_g must either be an element of $E_{(G)}$ or else it is not included in any $R_{(T)}$.

In a manner similar to that outlined for prime-power groups, the above fact makes the selection of all possible rings of transformations much easier. For instance, consider the cyclic group of order 6, in which $T_g = \begin{Bmatrix} 0 & 1 & 2 & 3 & 4 & 5 \\ a & b & c & d & e & f \end{Bmatrix}$. As for any transformation of a cyclic group which may be included in some $T_{(G)}$, $a = 0$. In addition, any T in which any non-zero element of the lower row is an element of G not divisible by p or q, namely 1 or 5, may be eliminated from consideration for inclusion in any ring other than $E_{(G)}$. This limits further consideration to transformations in which b, c, d, e, and f equal 0, 2, 3, or 4, a total of 4^5 possibilities.

In order to further reduce the number of possibilities, in equation (2) let $A = B = C = T_g$, and suppose $c = 2$. Expansion in the customary manner yields the result that if $c = 2$, then $e = 4$. In the same way, if $c = 4$, then $e = 2$; if $e = 2$, then $c = 4$; and if $e = 4$, then $c = 2$. Again, in equation (2), if b, c, d, e, or f equals 2, then $e = c + c$. In the same manner, if b, c, d, e, or f equals 4, then $c = e + e$; and if b, c, d, e, or f equals 3, then $0 = d + d$ and therefore $d = 0$ or 3.

Consequently, if any element in the lower row of T_g equals 2, then in order for T_g to be in any ring, $e = c + c$, and therefore $e = 0$, 2, or 4. If $e = 2$, $c = 4$. If $e = 4$, $c = 2$. If $e = 0$, $c = 0$ or 3. Suppose $c = 3$. In $T_g + T_g + T_g + T_g + T_g = T_5$, the element which originally equalled 2 now equals 4, and c_5 equals 3. But if some element of the lower row of $T_5 = 4$, then $c_5 = e_5 + e_5$. But this is impossible if $c_5 = 3$, since the sum of any element added to itself is 0, 2, or 4. Therefore, $c \neq 3$ when $e = 0$ and some element in the lower row of T_g equals 2. In the same manner, if any element in the lower row of T_g equals 4, then either $c = e = 0$, or $c = 2$ and $e = 4$, or $c = 4$ and $e = 2$. Recapitulating, if any element b, c, d, e, or f of T_g equals 2 or 4, then for that T_g to be in any ring of transformations one of the following conditions must hold: (1) $c = e = 0$; (2) $c = 2, e = 4$; (3) $c = 4$, $e = 2$.

With the above restrictive conditions, it is indicated that all rings of transformations of the cyclic group of order 6 may be derived as subrings of the following seven rings:

1. $E_{(G)}$, consisting of the six additive powers of the unity transformation 1. The order of the ring is 6.
2. R_1, in which in each T_{g1}, b, d, and f each equals 0 or 3, and c equals 0, 2, or 4, thus determining e. Its order is $2^3 \cdot 3 = 24$.
3. R_2, in which in each T_{g2}, b, c, d, e, and f equals 0 or 3. R_2 is of order $2^5 = 32$.
4. R_3, in which in each T_{g3}, b and c each equals 0, 2, or 4, thus determining e, and d and f each equals 0 or 3. R_3 is of order $3^2 \cdot 2^2 = 36$.
5. R_4, in which in each T_{g4}, b and d each equals 0 or 3, and c and f each equals 0, 2, or 4, thus determining e. R_4 is of order $2^2 \cdot 3^2 = 36$.
6. R_5, in which in each T_{g5}, b, c, and $f = 0$, 2, or 4, thus determining e, and $d = 0$ or 3. The order is $3^3 \cdot 2 = 54$.

7. R_6, in which in each T_{g6}, b, c, d, and f each equals 0, 2, or 4, thus determining e. R_6 contains $3^4 = 81$ elements.

Certain generalizations regarding cyclic groups of an order other than prime, in general, and groups of order pq, in particular, can now be made. First, the only $E_{(G)}$ which are integral domains and fields are the rings of endomorphisms of prime order groups and the ring of endomorphisms of the group of order 1, because only these rings of endomorphisms contain no divisors of zero. Second, in composite-order groups such as those of order pq, the number of transformations included in the ring of endomorphisms may be very small in comparison with the total number of elements included in the rings of transformations other than $E_{(G)}$. Third, the only integral domains and fields included as $R_{(T)}$ of composite-order or prime-power groups do not contain the unity transformation 1. A simple example of one of these fields of order 2, taken from the $T_{(G)}$ of the cyclic group of order 6, includes the transformations 0 and $A = \begin{Bmatrix} 0 & 1 & 2 & 3 & 4 & 5 \\ 0 & 0 & 0 & 3 & 0 & 0 \end{Bmatrix}$. Addition and multiplication are closed and commutative, $A \cdot A = A$, the multiplicative identity is A, and the multiplicative inverse of A equals A.

Transformation rings of the noncyclic group of order 4.—There are many types of non-cyclic groups, each having their own distinctive properties. The first such group to be considered is the commutative, lowest-order non-cyclic group of order 4, whose elements may be represented by 0, x, y, and z. x and y are independent generators of order 2, and $x + y = z$. The group addition table follows:

Addition Table of the Noncyclic Group of Order 4

	0	x	y	z
0	0	x	y	z
x	x	0	z	y
y	y	z	0	x
z	z	y	x	0

One example of such a group is the permutation group consisting of the identity 1, independent generators ab and cd which correspond to x and y above, and their "sum", which is defined as their sequential permutation $ab \cdot cd$, which corresponds to z. It should be noted that addition is commutative, and that every non-zero element is of order 2; that is, each element when added to itself gives the additive identity 0 as the resultant. The general transformation $T_g = \begin{Bmatrix} 0 & x & y & z \\ a & b & c & d \end{Bmatrix}$.

In order to determine which T_g may be in some ring, in equation (2) let $A = T_g$, and $B = C = 0$. The customary expansion yields the result that $a = a + a$. Therefore, in order for any T_g to be in the same ring as the transformation 0, which is included in every ring of transformations, T_g must be of the form $\begin{Bmatrix} 0 & x & y & z \\ 0 & b & c & d \end{Bmatrix}$. There are now $4^3 = 64$ $T_{(G)}$ which have not been excluded from consideration as elements of some $R_{(T)}$. Next, in equation (2), let $A = B = T_g$, and $C = T_g \cdot T_g$. If, in T_g, $b = y$ and $c = z$, equation (2) becomes:

$$\left[\begin{Bmatrix} 0 & x & y & z \\ 0 & y & z & d \end{Bmatrix} + \begin{Bmatrix} 0 & x & y & z \\ 0 & z & d & - \end{Bmatrix}\right]\begin{Bmatrix} 0 & x & y & z \\ 0 & y & z & d \end{Bmatrix}$$

$$= \begin{Bmatrix} 0 & x & y & z \\ 0 & y & z & d \end{Bmatrix}\begin{Bmatrix} 0 & x & y & z \\ 0 & y & z & d \end{Bmatrix} + \begin{Bmatrix} 0 & x & y & z \\ 0 & z & d & - \end{Bmatrix}\begin{Bmatrix} 0 & x & y & z \\ 0 & y & z & d \end{Bmatrix},$$

$$\begin{Bmatrix} 0 & x & y & z \\ 0 & y & - & - \end{Bmatrix} = \begin{Bmatrix} 0 & x & y & z \\ 0 & z & d & - \end{Bmatrix} + \begin{Bmatrix} 0 & x & y & z \\ 0 & d & - & - \end{Bmatrix}$$

Therefore:

$$y = z + d, \qquad \text{so } d = x.$$

In the same manner, if $b = y$ and $d = x$, then $c = z$; if $c = z$ and $d = x$, then $b = y$; if $b = y$ and $c = x$, then $d = z$; if $c = z$ and $d = y$, then $b = x$; if $b = z$ and $d = x$, then $c = y$; if $b = z$ and $c = x$, then $d = y$; if $b = z$ and $d = y$, then $c = x$; and if $c = x$ and $d = y$, then $b = z$. These conditions eliminate 21 more $T_{(G)}$ from consideration as elements of any $R_{(T)}$.

In order to determine the elements of $E_{(G)}$, in equation (3) let x and y equal, respectively, the elements x and y of G, and $A = T_g$:

$$\begin{aligned} (x + y)T_g &= xT_g + yT_g \\ d &= b \quad + c \end{aligned}$$

By substituting additional elements into equation (3), the following additional conditions are imposed on the elements of

$E_{(G)}$: (a) $b = c + d$, (b) $c = b + d$. No further conditions are imposed on T_g by substitution of any combination of elements of G in equation (3). The fact that the following 16 elements which satisfy the above relations and therefore comprise $E_{(G)}$ are closed with respect to addition and multiplication may be readily verified. The following transformations comprise $E_{(G)}$:

$$0 = \begin{Bmatrix} 0 & x & y & x \\ 0 & 0 & 0 & 0 \end{Bmatrix} \quad 1 = \begin{Bmatrix} 0 & x & y & z \\ 0 & x & y & z \end{Bmatrix} \quad A = \begin{Bmatrix} 0 & x & y & z \\ 0 & y & z & x \end{Bmatrix}$$

$$B = \begin{Bmatrix} 0 & x & y & z \\ 0 & z & x & y \end{Bmatrix} \quad C = \begin{Bmatrix} 0 & x & y & z \\ 0 & x & z & y \end{Bmatrix} \quad D = \begin{Bmatrix} 0 & x & y & z \\ 0 & z & y & x \end{Bmatrix}$$

$$E = \begin{Bmatrix} 0 & x & y & z \\ 0 & y & x & z \end{Bmatrix} \quad F_x = \begin{Bmatrix} 0 & x & y & z \\ 0 & 0 & x & x \end{Bmatrix} \quad F_y = \begin{Bmatrix} 0 & x & y & z \\ 0 & y & 0 & y \end{Bmatrix}$$

$$F_z = \begin{Bmatrix} 0 & x & y & z \\ 0 & z & z & 0 \end{Bmatrix} \quad G_x = \begin{Bmatrix} 0 & x & y & z \\ 0 & x & 0 & x \end{Bmatrix} \quad G_y = \begin{Bmatrix} 0 & x & y & z \\ 0 & y & y & 0 \end{Bmatrix}$$

$$G_z = \begin{Bmatrix} 0 & x & y & z \\ 0 & 0 & z & z \end{Bmatrix} \quad H_x = \begin{Bmatrix} 0 & x & y & z \\ 0 & x & x & 0 \end{Bmatrix} \quad H_y = \begin{Bmatrix} 0 & x & y & z \\ 0 & 0 & y & y \end{Bmatrix}$$

$$H_z = \begin{Bmatrix} 0 & x & y & z \\ 0 & z & 0 & z \end{Bmatrix}$$

In order to determine if A is in any ring other than a subring of $E_{(G)}$, in equation (2) let A, B, and C, respectively, equal T_g, A, and $A + A$ of $E_{(G)}$:

$$\left[\begin{Bmatrix} 0 & x & y & z \\ 0 & y & z & x \end{Bmatrix} + \begin{Bmatrix} 0 & x & y & z \\ 0 & z & x & y \end{Bmatrix}\right]\begin{Bmatrix} 0 & x & y & z \\ 0 & b & c & d \end{Bmatrix}$$

$$= \begin{Bmatrix} 0 & x & y & z \\ 0 & y & z & x \end{Bmatrix}\begin{Bmatrix} 0 & x & y & z \\ 0 & b & c & d \end{Bmatrix}$$

$$+ \begin{Bmatrix} 0 & x & y & z \\ 0 & z & x & y \end{Bmatrix}\begin{Bmatrix} 0 & x & y & z \\ 0 & b & c & d \end{Bmatrix}$$

$$\begin{Bmatrix} 0 & x & y & z \\ 0 & b & c & d \end{Bmatrix} = \begin{Bmatrix} 0 & x & y & z \\ 0 & c & d & b \end{Bmatrix} + \begin{Bmatrix} 0 & x & y & z \\ 0 & d & b & c \end{Bmatrix}$$

Therefore:

$$b = c + d; \; c = d + b; \; d = b + c.$$

Any T_g included in the same ring with A must therefore be in $E_{(G)}$, and consequently $E_{(G)}$ is not a subring of any larger $R_{(T)}$ and A is not in any ring other than subrings of $E_{(G)}$. In the same manner it may be shown that B, C, D, and E are in no ring other than subrings of $E_{(G)}$.

$E_{(G)}$ is neither an integral domain nor a field due to the presence of divisors of zero such as $F_x \cdot F_x = 0$. It may be shown that the largest field which is included as a subring of $E_{(G)}$ and contains 1 is of order 4 and includes 0, 1, A, and B.

In addition to the elements of $E_{(G)}$, the following 27 $T_{(G)}$ have not been eliminated from consideration as elements of some $R_{(T)}$:

$$J_x = \begin{Bmatrix} 0 & x & y & z \\ 0 & x & x & x \end{Bmatrix} \quad K_x = \begin{Bmatrix} 0 & x & y & z \\ 0 & x & 0 & 0 \end{Bmatrix}$$

$$L_x = \begin{Bmatrix} 0 & x & y & z \\ 0 & 0 & x & 0 \end{Bmatrix} \quad M_x = \begin{Bmatrix} 0 & x & y & z \\ 0 & 0 & 0 & x \end{Bmatrix}$$

$$J_y = \begin{Bmatrix} 0 & x & y & z \\ 0 & y & y & y \end{Bmatrix} \quad K_y = \begin{Bmatrix} 0 & x & y & z \\ 0 & 0 & y & 0 \end{Bmatrix}$$

$$L_y = \begin{Bmatrix} 0 & x & y & z \\ 0 & 0 & 0 & y \end{Bmatrix} \quad M_y = \begin{Bmatrix} 0 & x & y & z \\ 0 & y & 0 & 0 \end{Bmatrix}$$

$$J_z = \begin{Bmatrix} 0 & x & y & z \\ 0 & z & z & z \end{Bmatrix} \quad K_z = \begin{Bmatrix} 0 & x & y & z \\ 0 & 0 & 0 & z \end{Bmatrix}$$

$$L_z = \begin{Bmatrix} 0 & x & y & z \\ 0 & z & 0 & 0 \end{Bmatrix} \quad M_z = \begin{Bmatrix} 0 & x & y & z \\ 0 & 0 & z & 0 \end{Bmatrix}$$

$$N_{xy} = \begin{Bmatrix} 0 & x & y & z \\ 0 & x & y & 0 \end{Bmatrix} \quad P_{xy} = \begin{Bmatrix} 0 & x & y & z \\ 0 & x & 0 & y \end{Bmatrix}$$

$$Q_{xy} = \begin{Bmatrix} 0 & x & y & z \\ 0 & 0 & y & x \end{Bmatrix} \quad S_{xy} = \begin{Bmatrix} 0 & x & y & z \\ 0 & x & y & y \end{Bmatrix}$$

$$T_{xy} = \begin{Bmatrix} 0 & x & y & z \\ 0 & x & y & x \end{Bmatrix} \quad N_{yz} = \begin{Bmatrix} 0 & x & y & z \\ 0 & 0 & y & z \end{Bmatrix}$$

$$P_{yz} = \begin{Bmatrix} 0 & x & y & z \\ 0 & z & y & 0 \end{Bmatrix} \quad Q_{yz} = \begin{Bmatrix} 0 & x & y & z \\ 0 & y & 0 & z \end{Bmatrix}$$

$$S_{yz} = \begin{Bmatrix} 0 & x & y & z \\ 0 & z & y & z \end{Bmatrix} \quad T_{yz} = \begin{Bmatrix} 0 & x & y & z \\ 0 & y & y & z \end{Bmatrix}$$

$$N_{zx} = \begin{Bmatrix} 0 & x & y & z \\ 0 & x & 0 & z \end{Bmatrix} \quad P_{zx} = \begin{Bmatrix} 0 & x & y & z \\ 0 & 0 & x & z \end{Bmatrix}$$

$$Q_{zx} = \begin{Bmatrix} 0 & x & y & z \\ 0 & x & z & 0 \end{Bmatrix} \quad S_{zx} = \begin{Bmatrix} 0 & x & y & z \\ 0 & x & x & z \end{Bmatrix}$$

$$T_{zx} = \begin{Bmatrix} 0 & x & y & z \\ 0 & x & z & z \end{Bmatrix}$$

In equation (2) let $A = B = J_x$, and $C = T_g$. The only T_g which satisfy this equation and which may therefore be included in the same ring as J_x are those in which b, c, and d each equals 0 or x, namely 0,

F_x, G_x, H_x, J_x, K_x L_x, and M_x. The above eight elements of R_x are obviously closed with respect to both addition and multiplication, and it may be shown that they satisfy equation (2) by the following reasoning. Consider one element of any T_g of R_x such as b. If, in equation (2), b of A equals 0, then the equation will hold for b regardless of whether b equals 0 or x in B and C. Therefore, let b of A equal x. Now, if in C, b equals 0, then equation (2) again holds true regardless of whether b of B equals 0 or x. The same holds true for b of A if b of B equals 0. The only other possibility, namely that b equals x in A, B, and C, also satisfies equation (2), which becomes for b, $0 = x + x$. Therefore R_x is a ring of transformations. It is obvious that corresponding R_y and R_z, each of order 8, exist; and that J_x, J_y, and J_z do not belong to any ring other than subrings of R_x, R_y, and R_z, respectively.

In equation (2), let $A = B = S_{xy}$, and $C = T_g$. The only T_g which satisfy this equation are those in which $b = 0$ or x, and c and $d = 0$ or y; namely, 0, H_y, K_x, K_y, L_y, N_{xy}, P_{xy}, and S_{xy}. Since these transformations are closed with respect to addition and multiplication, and satisfy equation (2) for all combinations of T in R_2, which includes the above eight transformations, R_2 is a ring. Similar R_3, R_4, R_5, R_6, and R_7 exist, based upon S_{yz}, S_{zx}, T_{xy}, T_{yz}, and T_{zx}, respectively.

All of the 43 possible elements of some $R_{(T)}$ have now been shown to be elements of at least one $R_{(T)}$. The only $R_{(T)}$ not included as a subring of one of the ten rings previously considered is R_1, composed of 0, 1, K_x, K_y, K_z, N_{xy}, N_{yz}, and N_{zx}. Thus, it is indicated that all $R_{(T)}$ of the noncyclic group of order 4 may be expressed as subrings of the following $R_{(T)}$:

E: 0, 1, A, B, C, D, E, F_x, F_y, F_z, G_x, G_y, G_z, H_x, H_y, H_z.
R_1 : 0, 1, K_x, K_y, K_z, N_{xy}, N_{yz}, N_{zx}.
R_2 : 0, H_y, K_x, K_y, L_y, N_{xy}, P_{xy}, S_{xy}.
R_3 : 0, H_z, K_y, K_z, L_z, N_{yz}, P_{yz}, S_{yz}.
R_4 : 0, H_x, K_z, K_x, L_x, N_{zx}, P_{zx}, S_{zx}.
R_5 : 0, G_x, K_x, K_y, M_y, N_{xy}, Q_{xy}, T_{xy}.
R_6 : 0, G_y, K_y, K_z, M_z, N_{yz}, Q_{yz}, T_{yz}.
R_7 : 0, G_z, K_z, K_x, M_x, N_{zx}, Q_{zx}, T_{zx}.
R_x : 0, F_x, G_x, H_x, J_x, K_x, L_x, M_x.
R_y : 0, F_y, G_y, H_y, J_y, K_y, L_y, M_y.
R_z : 0, F_z, G_z, H_z, J_z, K_z, L_z, M_z.

All of these 11 $R_{(T)}$ contain divisors of zero, and consequently are neither integral domains nor fields. It should be noted that this non-cyclic group of order 4 is the first of the groups thus far considered in which the identity transformation is included in any ring other than $E_{(G)}$. In this group, the identity transformation is included in R_1, which is not even a subring of E, and in several subrings of $E_{(G)}$, such as F_1 : 0, 1, A, B which is also a field.

Transformation rings of the dihedral group of order 6.—A dihedral group is a non-cyclic group which is generated by two elements of order 2 whose product is of order h. Carmichael has shown that such a group is of order $2h$, that there is exactly one dihedral group of each even order greater than 2, and that the group is non-abelian if $2h$ exceeds 4. Since there is but one non-cyclic group of order 4 and one of order 6, it follows that the non-cyclic groups of order 4 and 6 are dihedral groups. However, the dihedral group of order 4 has many properties which differ from those of dihedral groups of order greater than 4. For instance, the group of order 4 is the only dihedral group which is abelian. So let us consider the dihedral group of order 6 as a representative example of such groups of order greater than 4.

In a manner similar to that used for the dihedral group of order 4, the abstract dihedral group of order 6 may be represented by the elements 0, v, w, x, y, and z. Their addition table is given below:

ADDITION TABLE OF THE NONCYCLIC GROUP OF ORDER 6

	0	v	w	x	y	z
0	0	v	w	x	y	z
v	v	w	0	y	z	x
w	w	0	v	z	x	y
x	x	z	y	0	w	v
y	y	x	z	v	0	w
z	z	y	x	w	v	0

One example of such a group is the permutation group consisting of 1, *abc*, *acb*, *ab*, *bc*, and *ac*, which correspond, respectively, to 0, v, w, x, y, and z. It should be noted that addition of v and w is commutative, while that of x, y, and z is not. v and w are

of order 3, while x, y, and z are of order 2.
$$T_g = \begin{Bmatrix} 0 & v & w & x & y & z \\ a & b & c & d & e & f \end{Bmatrix}.$$

If, in equation (2), $A = T_g$ and $B = C = 0$, expansion yields the result that $a = a + a$, and therefore $a = 0$ in any T_g which is an element of some $R_{(T)}$. Now, in the same equation, let A, B, and C equal T_g. If, in T_g, $b = v$, expansion of the equation proves that $c = v + v = w$. In the same manner, if $b = w$, $c = v$; if $c = w$, $b = v$; and if $c = v$, $b = w$. Therefore, if in any $T_{(G)}$ in any $R_{(T)}$, $b = v$ or w, then the value of c is uniquely determined, and conversely.

Again, let A, B, and C equal T_g. If, in T_g, b, c, d, e, or f equals v, by expansion of equation (2) $c = b + b$, and therefore $c = 0$, v, or w. In the same manner, if b, c, d, e, or f equals w, then $b = c + c$, and $b = 0$, v, or w. Suppose that some element in T_g equals v. Then, if $c = v$, $b = w$; if $c = w$, $b = v$; and if $c = 0$, $b = 0$, x, y, or z. If $T_5 = T_g + T_g + T_g + T_g + T_g$ the element which equals v in T_g equals w in T_5, and if b equals x, y, or z in T_g, then b equals x, y, or z, respectively, in T_5. But in T_5, $b_5 = c_5 + c_5$, and so b cannot equal x, y, or z. Therefore if in T_g, b, c, d, e, or f equals v or w, one of the following conditions must exist in order for T_g to be in some $R_{(T)}$: (1) $b = c = 0$; (2) $b = v, c = w$; (3) $b = w$, $c = v$.

In equation (2) again let $A = B = C = T_g$ and suppose b, c, d, e, or f equals x. By expansion of equation (2), $0 = d + d$. Therefore $d = 0$, x, y, or z. Suppose $d = y$, and let $T'_g = T_g \cdot T_g$. In T'_g the element which in $T_g = x$, equals y. In equation (1), let $A = T_g$ and $B = T'_g$. The element which equals x in T_g and y in T'_g, equals w in $(A + B)$ and v in $(B + A)$. Therefore equation (1) does not hold true under these conditions and so $d \neq y$ when some element equals x, if T_g may be in some $R_{(T)}$. By the same reasoning, $d \neq z$ under the same conditions. Therefore, if b, c, d, e, or f equals x, then $d = 0$ or x; and, in the same manner if b, c, d, e, or f equals y, then $e = 0$ or y; and, if b, c, d, e, or f equals z, then $f = 0$ or z.

Suppose in some T, an element in the lower row such as e equals x. Assume another T' in the same ring as T, in which T', e equals neither 0 nor x. Obviously if in equation (1) $A = T$ and $B = T'$, the equation is not satisfied. Therefore, if in T_g, b, c, d, e, or f equals x, then in any other transformation T'' in the same ring, the corresponding b, c, d, e, or f equals 0 or x. By the same reasoning, the same conclusion is valid for y and z, respectively, and for v and w, jointly. Thus, it is indicated that all $R_{(T)}$ of G may be expressed as subrings of the following $R_{(T)}$:

1. R_{vw}, in which in each T_g, b, d, e, and $f = 0$, v, or w, thus determining c. Its order is $3^4 = 81$.
2. R_x, in which in each T_g, b, c, d, e, and $f = 0$ or x. It contains $2^5 = 32$ elements.
3. R_y, in which in each T_g, b, c, d, e, and $f = 0$ or y. Its order is $2^5 = 32$.
4. R_z, in which in each T_g, b, c, d, e, and $f = 0$ or z. It contains $2^5 = 32$ elements.
5. R^1_{vwx}, in which in each T_g, b, e, and $f = 0$, v, or w, thus determining c, and $d = 0$ or x. It contains $3^3 \cdot 2 = 54$ elements.
6. R^1_{vwy}, in which in each T_g, b, d, and $f = 0$, v, or w, thus determining c, and $e = 0$ or y. Its order is $3^3 \cdot 2 = 54$.
7. R^1_{vwz}, in which in each T_g, b, d, and $e = 0$, v, or w, thus determining c, and $f = 0$ or z. Its order is $3^3 \cdot 2 = 54$.
8. R^2_{vwx}, in which in each T_g, b and $e = 0$, v, or w, thus determining c, and d and $f = 0$ or x. Its order is $3^2 \cdot 2^2 = 36$.
9. R^3_{vwx}, in which in each T_g, b and $f = 0$, v, or w, thus determining c, and d and $e = 0$ or x. Its order is $3^2 \cdot 2^2 = 36$.
10. R^2_{vwy}, in which T_g is formed the same as in R^3_{vwx} except that d and $e = 0$ or y.
11. R^3_{vwy}, in which in each T_g, b and $d = 0$, v, or w, thus determining c, and e and $f = 0$ or y. Its order is $3^2 \cdot 2^2 = 36$.
12. R^2_{vwz}, in which T_g is formed the same as in R^2_{vwx} except that d and $f = 0$ or z.
13. R^3_{vwz}, in which T_g is formed the same as in R^3_{vwy} except that e and $f = 0$ or z.
14. R_{vwxyz}, in which in each T_g, $b = 0$, v, or w, thus determining c, $d = 0$ or x, $e = 0$ or y, and $f = 0$ or z. Its order is $3 \cdot 2^3 = 24$.
15. R_{vwxy}, in which T_g is formed the same as in R_{vwxyz} except that $f = 0$, v, or w. Its order is $3^2 \cdot 2^2 = 36$.
16. R_{vwxz}, in which T_g is formed the same as in R_{vwxyz} except that $e = 0$, v, or w. Its order is $3^2 \cdot 2^2 = 36$.
17. R_{vwyz}, in which T_g is formed the same as in R_{vwxyz} except that $d = 0$, v, or w. Its order is $3^2 \cdot 2^2 = 36$.
18. R^1_{vwxy}, in which in each T_g, $b = 0$, v, or w, thus determining c, $d = 0$ or x, and e and $f = 0$ or y. Its order is $3 \cdot 2^3 = 24$.
19. R^2_{vwxy}, in which T_g is formed the same as in R^1_{vwxy}, except that $f = 0$ or x.
20. R^1_{vwxz}, in which in each T_g, $b = 0$, v, or w, thus determining c, $d = 0$ or x, and e and $f = 0$ or z. Its order is 24.

21. R^2_{vwxz}, in which T_g is formed the same as in R^1_{vwxz}, except that $e = 0$ or x.

22. R^1_{vwyz}, in which in each T_g, $b = 0$, v, or w, thus determining c, d and $e = 0$ or y, and $f = 0$ or z. Its order is 24.

23. R^2_{vwyz}, in which T_g is formed the same as in R^1_{wvyz}, except that $d = 0$ or z.

24. Nine rings, R^1_{xyz} through R^9_{xyz}, in which in each T_g, $d = 0$ or x, $e = 0$ or y, $f = 0$ or z, and b and c each equals 0 or x, 0 or y, or 0 or z, in any one ring. Since, in any R, b and c may each equal any one of three choices, there are nine rings of this type in all, each of order $2^5 = 32$.

25. Eight rings, R^1_{xy} through R^8_{xy}, in which in each T_g, $d = 0$ or x, $e = 0$ or y, and b, c, and f each equals 0 or x, or 0 or y, in any one ring. This type is of order $2^5 = 32$.

26. Eight rings, R^1_{xz} through R^8_{xz}, in which in each T_g, $d = 0$ or x, $f = 0$ or z, and b, c, and e each equals 0 or x, or 0 or z, in any one ring. This type is also of order 32.

27. Eight rings, R^1_{yz} through R^8_{yz}, in which in each T_g, $e = 0$ or y, $f = 0$ or z, and b, c, and d each equals 0 or y, or 0 or z, in any one ring. This type is also of order 32.

Thus, there is a total of 56 independent $R_{(T)}$ in the totality of transformations of the dihedral group of order 6. Only one of these, R_{vwxyz}, includes the unity transformation, and as will be demonstrated, this ring is not $E_{(G)}$.

Now consider the determination of the endomorphisms of G. Let x and y of equation (3) equal w, and $A = T_g$. Expanding equation (3) gives the result that $b = c + c$, and therefore $b = 0$, v, or w. Now let x and y of equation (3) equal v and w, respectively. Then $0 = b + c$, and so if $b = 0$, $c = 0$; if $b = v$, $c = w$; and if $b = w$, $c = v$.

If x and y of equation (3) equal, respectively, x and y of G, then $c = d + e$; if x and y of equation (3) equal, respectively, y and z of G, then $c = e + f$; and if x and y of equation (3) equal, respectively, z and x of G, then $c = f + d$. Suppose x and y of equation (3) each equals x of G. Then $O = d + d$, and so $d \neq v$ or w. In the same manner, if x and y of equation (3) each equals y of G, then e does not equal v or w. By a similar use of z of G, it may be shown that $f \neq v$ or w. Now select a possible $T_{(G)}$ in which $c = v$. Then d, e, and f must each equal O, x, y, or z. In $T_2 = T + T$, $c_2 = w$ and $d = e = f = O$. Therefore T_2 does not satisfy the relation $c_2 = d_2 + e_2$, and consequently is included in no $E_{(G)}$. T is also thereby excluded from every $E_{(G)}$, if $c = v$. The same method of reasoning applies when $c = w$. Therefore, since $O = b + c$, in any T which may be in some $E_{(G)}$, $b = c = O$. The only $T_{(G)}$ which satisfy the relations $c = d + e = e + f = f + d$ and $b = c = O$ are the transformations O, $T_x = \begin{Bmatrix} O & v & w & x & y & z \\ O & O & O & x & x & x \end{Bmatrix}$, $T_y = \begin{Bmatrix} O & v & w & x & y & z \\ O & O & O & y & y & y \end{Bmatrix}$, and $T_z = \begin{Bmatrix} O & v & w & x & y & z \\ O & O & O & z & z & z \end{Bmatrix}$. Obviously T_x, T_y, and T_z are not commutative with respect to addition, and therefore do not satisfy equation (1). However, O and T_x are closed with respect to addition and multiplication, and satisfy equation (3) for all elements of G. Also, since T_x is the multiplicative identity and its own inverse, E_x: O, T_x is a field, in addition to being an integral domain and a ring of endomorphisms. Since similar reasoning is applicable to E_y: O, T_y and E_z: O, T_z there are three rings of endomorphisms of the non-cyclic group of order 6, E_x E_y, and E_z, each a field of order 2.

It should be noted that the identity transformation, although it is an endomorphism, belongs to no $E_{(G)}$, because $1 + 1 = \begin{Bmatrix} O & v & w & x & y & z \\ O & w & v & O & O & O \end{Bmatrix}$ is not an endomorphism. This can be readily demonstrated by letting x and y of equation (3) equal, respctively, x and y of G.

Transformation rings of the general dihedral group.—Consider the general dihedral group of order $2h$, where h is greater than 2.

Addition Table of the Dihedral Group of Order $2h$

	O	v	w...g	h	x	y...2h
O	O	v	w...g	h	x	y...2h
v	v	w	q...h	O	y	r... x
.	.	.	.....	.	.	.... .
h	h	O	v...f	g	2h	x... k
x	x	.	.....	k	O	.... .
.	.	.	.....	.	.	.... .
2h	2h	.	....	x	h	.... O

The general transformation

$$T_g = \begin{Bmatrix} 0 & v & w & \cdots & g & h & x & y & \cdots & z & 2h \\ a & b & c & \cdots & e & f & j & k & \cdots & m & n \end{Bmatrix}.$$

By the same reasoning as that used with the dihedral group of order 6, if T_g is in some $R_{(T)}$, then $a = 0$. Now, since $0, v, \cdots, h$ is a cyclic subgroup of G, in any endomorphism $\begin{Bmatrix} 0 & v & \cdots & h & \cdots \\ 0 & b & \cdots & f & - \end{Bmatrix}$ will be an additive power of $\begin{Bmatrix} 0 & v & \cdots & h & \cdots \\ 0 & v & \cdots & h & - \end{Bmatrix}$. Substituting x and y of G in equation (3), f of $T_g = j + k$. Continuing the process $f = j + k = \cdots = m + n = n + j$. And, as in the dihedral group of order 6, since $0 = j + j = k + k = \cdots = n + n$, the only $T_{(G)}$ which fulfil these conditions are of the form $T_s = \begin{Bmatrix} 0\ v \cdots h\ x \cdots 2h \\ 0\ 0 \cdots 0\ s \cdots s \end{Bmatrix}$ where s takes on values $x, y, \cdots, z, 2h$. Therefore, since no two T_s are commutative with respect to addition, there are h rings of endomorphisms in the transformations of a dihedral group of order $2h$, each a field of order 2, containing (0) and T_s.

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PALEONTOLOGY.—*Annotated list of fossil Mammalia associated with human remains at Melbourne, Fla.*[1] C. Lewis Gazin, U. S. National Museum.

Particular interest is attached to the association of Mammalia represented at the fossil site near Melbourne, Fla., not only in the occurrence there of relatively adequate human remains but also in the representation of a so nearly complete fauna at a single locality. Moreover, the association as a whole tends to give evidence for the relatively late Pleistocene survival of many extinct types, at least insofar as Florida is concerned, and at the same time demonstrates an early appearance of man.

Much has been written on the Pleistocene faunas of Florida, particularly by Simpson, Sellards, and Hay, which might appear to render the present report unnecessary. However, it seems advisable that the various localities be treated separately as a matter of record, even though in any particular case the horizon worked may be known to be bed no. 2 or the Melbourne Bone Bed. There remains the possibility, as suggested by Douglas Johnson, that this bed, because of the nature and mode of its accumulation might not everywhere be of the same age. Hence, the fauna at the Melbourne locality in particular, as well as that at Vero, because of the inclusion there of important human remains should be carefully and completely documented. An earlier listing of the Melbourne fauna by Gidley (1927), and as emended by Simpson (1929), preliminary in nature and very incomplete, was based only on collections obtained up to 1926.

The history of the investigation of the Melbourne occurrence, so far as the hominid remains are concerned has been summarized by T. D. Stewart (1946). His reexamination and review of Melbourne Man were well done and constituted a necessary correction of the earlier work of Hrdlička (1937).

Gidley's field work in Florida began in 1925, at which time a joint expedition with F. B. Loomis was arranged to investigate the Melbourne occurrence on the grounds of the Country Club golf course, originally discovered by a local resident, C. P. Singleton. This and Gidley's subsequent seasons were reported in a series of popular accounts in *Explorations and field work of the Smithsonian Institution* for 1925, 1928, 1929, and 1930. Gidley collected there also in 1926, and although he was in Florida in 1927 there is no evidence that he worked at Melbourne that year.

Gidley died shortly after his last season at Melbourne, and not all the collection was unpacked. I have since found that much of it was not carefully labeled, but sufficient evidence remains to demonstrate for any particular form, except as otherwise noted, its occurrence either in bed no. 2 or at the contact plane between beds 2 and 3. In any case, the occurrence of human bones beneath the top of no. 2 establishes their contemporaneity with the other Mammalia in the upper part of no. 2 and at the contact plane.

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received October 10, 1950.

It has been maintained, particularly by Hay (1926), that the evidence furnished by many of the extinct forms in the fauna is for an early Pleistocene age. Although over half of the forms represented are extinct, I see no justification for this conclusion. The large number of extinct types included, however, does argue for a Pleistocene rather than a Recent age assignment. That the stage of the Pleistocene is late is indicated by striking closeness or identity to living forms shown by those representatives of lines which did not become extinct in this area. It has also been suggested that Florida served as a haven for types disappearing in more northerly areas, that the fauna was largely relict. It seems likely that the fauna is residual to a limited extent and that some of the forms died out at earlier dates to the north, but the preponderantly Pleistocene aspect of the fauna cannot be reconciled with a post-Wisconsin age. Were one to postulate survival of such a large number of extinct forms into postglacial time the question arises why some (or more?) did not return northward with the return of more equitable conditions.

The mammalian fauna as recognized is comprised of 50 forms, about 28 of these are extinct, and of the genera, 13 are extinct. There is a strong probability that with the exception of bats and some rodents the fauna obtained is very nearly complete, and in comparison with the living fauna is about 50% larger.

MARSUPIALIA

Didelphis virginiana Kerr

The opossum is well represented in the collection by jaws and teeth, and, as elsewhere in the Pleistocene of North America, cannot be distinguished from the living species.

INSECTIVORA

Scalopus aquaticus (Linnaeus)

Among the assortment of small mammal bones are recognized some 40 of the characteristic humeri of this common mole.

Insectivore?, indet.

A single lower molar of a type resembling that seen in *Blarina*, but considerably larger, and of a different construction than in *Scalopus* is included in the collection. It is much smaller than in *Didelphis virginiana*, although a small marsupial might be represented.

PRIMATES

Homo sapiens Linnaeus

The skull, lower jaw, and other portions of the human skeleton found in bed no. 2, or the Melbourne formation, have been redescribed in detail by T. D. Stewart (1946).

EDENTATA

Megalonyx jeffersonii (Desmarest)

A megalonychid ground sloth of strikingly large size is referred to *M. jeffersonii*. The material consists for the most part of scattered teeth although their arrangement in the collection suggests in some cases associated material. There are in addition broken portions of both rami of a lower jaw, but with no certain association of teeth. An upper and lower caniniform tooth, probably from one individual, measure 130 mm in over-all length, 44 mm in anteroposterior diameter, and 20 mm in transverse diameter for upper tooth and 120 mm in over-all length, 43 mm in anteroposterior diameter, and 17 mm in transverse diameter for the lower tooth.

Megalonyx cf. **wheatleyi** Cope

A number of isolated teeth, significantly smaller than those referred to *M. jeffersonii* are regarded as representing a distinct species of *Megalonyx*.

Following the suggestion made by Simpson[2] for the Sabertooth Cave material these are tentatively referred to one of the species Cope described from Port Kennedy, *M. wheatleyi*.

Certain foot material, including a navicular, in the Melbourne collection cannot be certainly restricted to this or to *M. jeffersonii*.

Paramylodon cf. **harlani** (Owen)

Remains of mylodont sloth are scarce at Melbourne. Only a few teeth, nearly all of which are at an immature stage of wear, are recognized as belonging to this type of sloth. These youthful teeth are decidedly conical and show at their small bevelled end an approximation of the mature pattern.

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[2] Simpson, G. G., Amer. Mus. Nov. no. 328: 11–13. 1928.

Dasypus bellus (Simpson)

A nine-banded armadillo that Simpson[3] has given the name of *Tatu bellus* is represented in the Melbourne collection by literally hundreds of scutes from all sections of the carapace. I have not examined the lower jaw that Simpson described briefly and identified as coming from Melbourne. It does not appear to be in the collections of the National Museum.

Holmesina septentrionalis (Leidy)

The bulk of sloth material belongs to the giant armadillo that Leidy[4] described from Peace Creek, Fla. The genus *Holmesina* was proposed by Simpson[5] in keeping with a refinement of chlamythere genera of South America made by Castellanos.[6]

In addition to a rather large number of scutes, the Melbourne collection includes elements of a forelimb and isolated foot and toe bones.

Boreostracon floridanus Simpson

In contrast to armadillo representation there are but five or six scutes of glyptodon. These are referred to the species described by Simpson[7] from the Seminole Field locality in Pinellas County.

LAGOMORPHA

Sylvilagus floridanus (Allen)

The Florida cottontail is represented by but four lower jaws. The cheek teeth in these exhibit the relatively simple enamel pattern characterizing the modern material of Florida, and differ from the subspecies *S. floridanus floridanus* only in a slightly greater average size.

Sylvilagus palustris (Bachman)

More than 40 jaws and maxillae are referred to *Tapeti* or the marsh rabbit. There is noticeable variation in size and in the depth and complexity of the tooth enamel crenulations, particularly on the anterior wall of P_3. The fossil material closely resembles the living form. The appearance of "*Lepus*, sp." in the faunal list Gidley (1927) furnished Hay is based on a specimen of *Sylvilagus palustris*.

Sylvilagus palustrellus, n. sp.

Type.—Left ramus of mandible with P_3 to M_2 incl., U.S.N.M. no. 18593.

Horizon and locality.—Melbourne formation, Melbourne, Fla.

Specific characters.—Size about two-thirds that of *Sylvilagus palustris*. Jaw shallow and teeth relatively narrow transversely. Posterior leg of median enamel loop in lower cheek teeth crenulated as in *S. palustris*, but anterior wall of P_3 shows but a single shallow fold.

A second specimen which is undoubtedly of the same species was collected by G. S. Miller on Sugarloaf Key, Fla. in 1935. It has a U.S.N.M. Div. Mammals number 259231. The specimen is light in color, shows evidence of weathering, and has dark, sandy, carbonaceous matrix adhering to it. It is possible that this specimen is a fossil and subrecent in age.

Other, more fragmentary specimens in the Melbourne collection may belong to this species, which may be regarded as a pigmy marsh rabbit.

RODENTIA

Geomys cf. **floridanus** (Audubon and Bachman)

The Florida gopher is well represented by lower jaws. Considerable size range exists, and on the basis of the material at hand I was unable to distinguish the fossil material from *Geomys tuza*, which is defined as having a more northerly range.

Castoroides cf. **ohioensis** Foster

A single incisor portion was collected by Gidley in February 1930. There is no locality indicated on the specimen label, but although some excavation work was done this year at Indiantown, the bulk of the collection came from Melbourne. *Castoroides* was also recorded from near Sarasota, Fla., in beds regarded as equivalent to those at Melbourne.

Oryzomys, sp.

Three rather well preserved lower jaws, but lacking cheek teeth, are determined as representing the rice rat. Critical comparisons were not feasible so no specific reference is made.

Sigmodon hispidus Say and Ord

About 15 jaws of cotton rat are preserved, and these show no significant differences from the modern form. In these specimens, as well as in the modern material, considerable variation exists in the presence or absence and state of development reached in the postero-internal enamel fold on first and second lower cheek teeth.

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[3] Simpson, G. G., Bull. Amer. Mus. Nat. Hist. **56**: 579–580. 1929.

[4] Leidy, Joseph, Proc. Acad. Nat. Sci. Philadelphia, 1889: 97.

[5] Simpson, G. G., Amer. Mus. Nov. no. 442: 1–10. 1930.

[6] Castellanos, Alfredo, Centro Estud. de Ingeneria de Rosario, 1927: 1–8.

[7] Simpson, G. G., Bull. Amer. Mus. Nat. Hist. **56**: 581–583. 1929.

Neotoma floridana (Ord)

The wood rat is well represented considering its scarcity at other Florida occurrences. No differences from the living species were observed other than some of the jaws appear rather large.

Neofiber cf. **alleni** True

Round-tailed muskrats are second in abundance only to gophers among the rodents in the collections. The fossil material corresponds closely in size to *N. alleni* but the enamel loops of the lower cheek teeth appear less markedly closed on the average, particularly the anterior loop of the last lower molar.

Neochoerus pinckneyi (Hay)

A tooth that appears to be a left P^4 in the Melbourne collection, but without precise locality and horizon data, except for the year 1926, represents the giant capybara. The tooth is approximately 50 per cent larger than in large recent capybaras but does not exhibit the additional external enamel fold on the second plate mentioned by Simpson[8] for the Bradenton, Fla., skull. The Melbourne tooth might be one of the anterior molars, but comparison with *Hydrochoerus isthmius* suggests P^4.

CARNIVORA

Canis (Aenocyon) cf. **ayersi** Sellards

More than two dozen isolated teeth and a nearly complete right ramus of the mandible are seen as belonging to the Florida dire wolf. Comparison with equivalent material of *C. Aenocyon dirus* from Rancho La Brea reveals that no significant differences are to be found on the basis of lower jaw and tooth material. The principal distinguishing feature of *C. ayersi* is described as the relative long and narrow rostrum of the skull. It remains for future material to demonstrate the persistence of this and certain other characteristics and it should be noted that recent wolves, as well as Rancho La Brea dire wolves, show striking individual variation in skull proportions.

Canis riviveronis Hay

The coyote, not now living in Florida, is represented at Melbourne, and elsewhere in the Melbourne beds, apparently by the extinct species *C. riviveronis*. The fossil type is very near the western coyote, *Canis latrans*, in size and most dental features, and may not be distinct. However, the shortness of the anterior portion of the upper carnassial, which Hay included in his diagnosis of the Vero species appears reflected in the shortness of the triconid portion of the lower carnassial noticed in the Melbourne material. The coyote is represented at Melbourne by an incomplete right ramus of the lower jaw with M_1 and M_2 and by about 12 isolated teeth.

Urocyon cf. **cinereoargenteus** Schreber)

A maxillary portion with P^3 and P^4, and about six isolated teeth, including upper and lower carnassials, of gray fox are apparently referrable to the modern species. The maxilla cannot be distinguished from material of the living species, except possibly for a somewhat better developed antero-external angle to the cingulum of the upper carnassial. The lower carnassial does not have a reduced metaconid as described for *Urocyon seminolensis*[9], and no certain evidence of the presence of the red fox *Vulpes* could be found in the Melbourne canid material, although an M^1 and two isolated premolars appear relatively large for *Urocyon*, and probably too small, certainly the molar, for coyote.

Arctodus floridanus (Gidley)

The tremarctine bear *Arctodus floridanus* was described by Gidley (1928) on the basis of material from the Melbourne locality. In addition to the type, which consists of skull fragments with upper canines and molars and the greater part of the left mandibular ramus, there are at least three more lower jaws, a pair of maxillae with teeth, and two dozen or so isolated teeth. Most of these were collected shortly after the description was published. The teeth in the referred maxillae are strikingly smaller than in the type and would appear to represent a distinct species; however, an examination of the extent of size variation of teeth in *Tremarctos* revealed an amazing difference due to sex dimorphism. In the American black bear the dimorphism does not appear to extend to the size of the cheek teeth.

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[8] Simpson, G. G., Amer. Mus. Nov. no. 406: 8. 1930.

[9] Simpson, G. G., Bull. Amer. Mus. Nat. Hist. **56**: 575. 1929.

Ursus (Euarctos) cf. **floridanus** (Merriam)

The greater part of a skull and both lower jaws with most of the teeth, together with a few cervical vertebrae from one individual is referred tentatively to the Florida species of the black bear. Such reference is not intended to imply support to recognition of *U.* (*E.*) *floridanus* as of more than a subspecies of *U.* (*E.*) *americanus*, but is in keeping with Miller's check list.[10]

With regard to the above specimen the softness of bone in comparison to the better indurated *Arctodus* material leads me to suspect that it might have come from bed "3", as the locality data is incomplete in this respect. There is very little other material in the collection which can be clearly assigned to black bear.

Ursus, sp.

The left half of the rostrum of a skull and a few cervical vertebrae believed to be associated are regarded as representing true *Ursus*. The rostrum of this form is short and deep, and the canine and last upper molar (M^2) are of remarkably large size. In the size of these two teeth no approximation could be found in any of the many black bear skulls in the National Museum examined. On the other hand a favorable comparison was made with small toothed individuals of *Ursus horribilis*, so far as canine and M^2 are concerned, but M^1 and particularly P^4 are noticeably smaller. The cheek teeth in general are only a little larger than those in the type of *Arctodus floridanus* but the inner-cingulum and pattern details of the upper molars, and the structure of the zygomatic wing of the maxilla with the infraorbital canal are not *Arctodus*-like but truly ursine. I suspect a distinctive species is represented, possibly near in size to *Ursus procerus* Miller but in view of the profusion of names which have been applied to recent members of a highly variable animal I hesitate to add to the confusion.

Procyon lotor (Linnaeus)

Nearly 40 jaws, about 6 maxillae, and numerous isolated teeth of raccoon in the Melbourne collection appear referable to the living species *P. lotor*. Although much size variation exists within the material, none of the upper dentitions appeared small enough, or to have exhibited characters suggesting *Procyon nanus* Simpson. However, a few of the isolated lower teeth were noticeably small, but no comparison could be made inasmuch as lower jaw material of *P. nanus* is unknown or undescribed.

Spilogale ambarvalis Bangs

A single right mandibular ramus with P_2 to M_1 inclusive cannot be distinguished from jaws of the spotted skunk representing the present-day Floridian fauna.

Lutra canadensis (Schreber)

The Canadian otter is represented by various subspecies in Florida, and although the Melbourne fossil material cannot be assigned to any of them with assurance there is little doubt but that the otter living in the late Pleistocene at Melbourne, as well as other localities in Florida, was *L. canadensis*.

Panthera augusta (Leidy)

The Melbourne jaguar material has been described and figured by Simpson[11]. His critical analysis of these and other specimens from the Pleistocene of North America has demonstrated that with some degree of probability the various finds which have been referred to such species as *F. augusta* and *F. veronis* are scarcely more than a subspecies of *Panthera onca*. Since then McCrady[12], from additional Tennessee material, has come to the conclusion that *P. augusta* might well be regarded as a distinct species.

The presence of jaguar in the North American Pleistocene was not early recognized, but in the work of Merriam and Stock[13] such a relationship was outlined for *Felis atrox*, and attention was called to similar conclusions by Freudenberg. E. A. Goldman was much impressed by the similarity between *F. atrox* and *F. onca* and succeeded in convincing, by demonstration of material, other zoologists and paleontologists with whom he discussed this relationship. No doubt Gidley regarded the Florida material as jaguar, and Simpson in his review of the "Large Pleistocene Felines of North America" through a careful analytical study of the known specimens substantiated such conclusions and straightened out the taxonomic confusion.

Felis (Lynx) rufa Schreber

Referred to the modern lynx is a rather well preserved left mandibular ramus with the canine, P_4 and M_1, and in addition there are two jaw portions with premolars only and four isolated upper and lower carnassials. All materials appear to be well within the range of living Florida lynx. The generic name here used is in keeping with Simpson's revision of the felids in his classification of the Mammalia.

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[10] Miller, G. S., U. S. Nat. Mus. Bull. **128**: 92. 1923.

[11] Simpson, G. G., Amer. Mus. Nov. no. 1136: 1–27, figs. 1–11 (1). 1941.

[12] Manuscript in press.

Felis, sp.

A smaller cat than the lynx, with more slender teeth, particularly P_4, is represented by a right mandibular ramus with P_4 and M_1. Gidley's specimen label had this indicated as a new species of *Herpailurus*, and derived from bed no. 2 at the Melbourne golf links. The specimen strongly resembles material of the jaguarundi but is a trifle large and deeper jawed, and on the other hand resembles just as closely material of *Felis tigrina glaucula* representing the subgenus *Margay*. These small tropical cats range well up into Mexico, particularly the jaguarundi, which is recorded in Texas. Difficulty attaches to assignment of the fossil to one or the other of the small felids in being unable to certainly distinguish them, one from another, solely on characteristics of the two teeth and portion of the jaw represented by the fossil.

Smilodon cf. **floridanus** (Leidy)

An isolated upper carnassial of a sabertooth type in all probability represents Leidy's *S. floridanus*. The size of the tooth is but slightly smaller than that which would have occupied the alveolus in the type. The tooth is appreciably smaller than in *Smilodon californicus*, and it is actually slightly shorter than the least dimenion given by Merriam and Stock[14] for the Rancho La Brea specimens.

PROBOSCIDEA

Mammut americanum (Kerr)

The American mastodon is rather adequately represented by two partial skeletons including jaw material and various isolated teeth. I see no reason for regarding the form occurring in the Melbourne bed as distinct from the common Pleistocene species of North America.

Mammuthus columbi (Falconer)

According to Hopwood[15] and as supported by Simpson, the Pleistocene mammoth, if not to be included in *Elephas*, has for the earliest available generic name, *Mammuthus*. The bulk of the Melbourne material, consisting for the most part of isolated teeth in the National Museum collections, but including a skeleton now mounted for exhibition at Amherst, belongs without question to the columbian mammoth.

Mammuthus imperator? (Leidy)

Gidley[16] was convinced that certain of the teeth from Melbourne represent the imperial mammoth, presumably from the spacing of the enamel plates, which does about equal that in the type, but these particular Melbourne teeth are not so wide and generally less robust than indicated for *M. imperator* type material. The mammoth teeth in the Melbourne collection regarded as representing *M. columbi* show very considerable variation in spacing of plates and with one so closely spaced as to have suggested to Gidley the presence of "*E. boreus*" as shown by his specimen label.

PERISSODACTYLA

Equus complicatus Leidy

There is among Gidley's collections of various years from Melbourne something over 250 teeth belonging to Pleistocene horses. Of these there appears to be less than two dozen which would be logically referred to *E. complicatus* if more than one species is to be recognized. These are among the largest of the collection, corresponding closely in size to the type of the species.

Equus leidyi Hay

The bulk of the horse teeth, including those in several dentitions and jaws, are of intermediate size, though not sharply separated from *E. complicatus* on this basis, and there is no persistent difference in the pattern of the enamel which can be used to define the species. No attempt is made in this paper to revise the many species of Pleistocene horses; as a consequence the material here encountered is taxonomically arranged as has been done in previous studies of Florida Pleistocene faunas.

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[13] Merriam, J. C., and Chester Stock, Carnegie Inst. Washington Publ. **422:** 195–199. 1932.

[14] Merriam, J. C., and Chester Stock, *ibid.*

[15] Hopwood, A. T., Palaeontologia Sinica, ser. C, **9** (3): 97–98. 1935.

[16] Gidley, J. W., *in* H. F. Osborn, Proboscidea **2:** 996, 1005. 1942.

Equus littoralis? Hay

Scarcely more than 10 or 12 of the isolated teeth can be regarded as small enough to comply with Hay's[17] definition of *E. littoralis*. These teeth exhibit no distinctive dental pattern and no sharp line can be drawn between them and the smaller teeth included under *E. leidyi*. They do, however, form a striking contrast in size with the teeth allocated to *E. complicatus*.

Tapirus cf. **haysii** Leidy

Included in the remains of tapir there is a complete upper cheek tooth series from both sides in which the teeth are relatively large for *Tapirus veroensis*. These approximate the proportions seen in an incomplete skull of *T. haysii* from Port Kennedy. The premolars of the Melbourne specimen are relatively a little larger than in *T. veroensis*. Certain isolated teeth also appear large in comparison with corresponding teeth in the type and referred material of *T. veroensis*.

Tapirus veroensis Sellards

The five lower jaws, several portions of dentitions, and most of the isolated teeth comprising the tapir material from Melbourne are regarded as representing the Vero tapir. The development of the parastyle on the upper cheek teeth does not appear significant in the diagnosis of *T. veroensis* as this cusp is certainly not less developed in the Port Kennedy *T. haysii*. Moreover, the cuspule between the protocone and hypocone seen in the type of *T. veroensis* is not always present, or may be but very slightly developed, in referred material of *T. veroensis*.

ARTIODACTYLA

Platygonus, near **P. compressus** LeConte

Among the fragmentary peccary remains, an incomplete lower jaw including parts of both rami, the symphysial portion and most of the cheek teeth belong to a moderate sized species of *Platygonus*. It corresponds most closely to *P. compressus*, but with teeth a trifle larger. The diastema between the cheek teeth and canines, however, is fully as short as or shorter than in the *P. compressus* specimen which Leidy[18] described from Kentucky, very much shorter and the jaw is shallower than in *P. cumberlandensis*.

Platygonus cf. **cumberlandensis** Gidley

A few of the isolated teeth of Platygonus are of larger size than those belonging to the above species and suggest possibly that *P. cumberlandensis* or a species of equivalent size is represented in the fauna.

Mylohyus gidleyi Simpson

Undoubtedly much of the *Mylohyus* peccary material belongs to the species which Simpson[19] has named *M. gidleyi*. One lower jaw portion with $P_3 - M_1$ corresponds very closely. This specimen shows the relatively small premolars which distinguishes *M. gidleyi* from *Mylohyus exortivus*. Also, there is among the isolated teeth a P_2 that has a single cusp representing the trigonid portion as in *M. gidleyi*. This tooth lacks the parastylid characterizing recent *Tayassu* material.

Mylohyus cf. **exortivus** Gidley

Some of the isolated teeth and partial dentitions of *Mylohyus* are fully as large as in *M. exortivus*, but not so large as in *M. pennsylvanicus*. Moreover, a second P_2 in the collection has its trigonid portion divided as generally characteristic of *Mylohyus*, and as seen in *M. exortivus*.

Tayassu, sp.

At least 10 of the isolated teeth, apparently all upper molars, have the external cingulum too well developed for inclusion in *Mylohyus*. Also, a small number show somewhat more crenulation of the enamel about the cusps than is probable for *Mylohyus*, suggesting that *Tayassu* is represented. The teeth are comparable in size to those in *Tayassu pecari* except for an M^3 that appears relatively narrower.

Tanupolama mirifica Simpson

Eleven isolated teeth and two partial dentitions, together with a few fore limb and foot elements comprise the camelid material in the Melbourne collection. All of this appears to represent a single species belonging to the slender-limbed *Tanupolama*. The form represented cannot be distinguished from that which Simpson[20] has described as *T. mirifica* from the Seminole Field. It is interesting to note that Gidley had prepared specimen labels for some of this material with a new generic name, which would have been valid had he published at that time (1924).

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[17] Hay, O. P., Proc. U. S. Nat. Mus. **44:** 575–576. 1913.

[18] Leidy, Joseph, Trans. Amer. Philos. Soc. **10:** 331–341, pls. 36, 37. 1853.

[19] Simpson, G. G., Bull. Amer. Mus. Nat. Hist. **56:** 591–592, figs. 15, 16B. 1929.

[20] Simpson, G. G., *ibid.*: 593–596. 1929.

Odocoileus virginianus (Boddaert)

Remains of white-tailed deer are among the most abundant of the mammals represented in the fauna. Numerous horn portions, some of which are nearly complete, several jaws, and many isolated teeth, as well as an assortment of limb bones and vertebrae, are included. Assignment to the virginia deer is in conformity with current taxonomic work in which *O. osceola* is regarded as a subspecies of *O. virginianus*. There appears to be no evidence in the materials at hand of the South American *Blastocerus* which Simpson[21] recognized in the Citrus County Cave.

Cervus? sp.

A single isolated upper cheek tooth of cervid type cannot be referred to *Odocoileus virginianus*. In size it corresponds closely to a Dp^4 of *Cervus canadensis* but does not appear to be a milk tooth. Consideration has been given to the possibility of it being an upper milk tooth of bison but the resemblance in this case seems even more remote. It likely represents an intermediate sized cervid, such as has been noted in various Pleistocene occurrences in this country.

Bison, sp.

An assortment of limb and foot bones, jaw portions, and isolated teeth of a relatively large bison cannot, in the absence of skull and horn material, be identified specifically. Bison material from several Pleistocene occurrences in Florida have been referred to *B. latifrons*, but I am unable to verify its occurrence at Melbourne.

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MYCOLOGY.—*A* Harposporium *infecting eelworms by means of externally adhering awl-shaped conidia.*[1] Charles Drechsler, Bureau of Plant Industry, Soils, and Agricultural Engineering.

The genus *Harposporium* was erected by Lohde (*6*) in 1874 on a hyphomycetous nematode parasite that produced sickle-shaped conidia on slender sterigmata arising from globose diverticulations borne laterally on filamentous hyphae extended from the body of the animal host. This parasite he designated as *H. anguillulae*, but since in its brevity the original descriptive account—apparently only a recorder's report of an oral discourse—contained little intimate detail, a really precise definition of the species was lacking until Zopf (*7*) 14 years later furnished very adequate particulars from study of an eelworm parasite that he had found in several localities in Germany and held identical with Lohde's. There is, indeed, much likelihood that the identification was correct, for although the characterization given by Lohde would seem to fit tolerably well one other nematode-destroying form that has appeared in my cultures, the fungus described by Zopf seems of far more frequent occurrence, at least in the Middle Atlantic States, than any hyphomycetous nematode parasite that could be regarded as congeneric with it. Conidia not typically falcate are produced by four allied species I have set forth as members of the genus (*1*, pp. 793–800; *4*) under the binomials *H. helicoides*, *H. oxycoracum*, *H. diceraeum*, and *H. bysmatosporum*; the inclusion of these species being justified more especially by the subglobose shape of the lateral cells bearing the sterigmata on which the conidia are formed. More recently another nematode parasite was found that seems best referable to the genus, though its conidiiferous cells depart rather markedly from the subspherical type.

This parasite came to light in more than a dozen maizemeal-agar plate cultures which after being overgrown with mycelium of *Pythium ultimum* Trow, had been further planted with small quantities of decaying grass taken from an old weed pile in a garden near Beltsville, Maryland, on February 2, 1950. Among the intermixed decaying leaves and culms, inflorescences of crabgrass (*Digitaria sanguinalis* (L.) Scop.), goosegrass (*Eleusine indica* (L.) Gaertn.), bristlegrass (*Setaria* sp.), and Bermuda-grass (*Cynodon dactylon* (L.) Pers.) remained easily recognizable. Rapid multiplication of eelworms ensued after the detritus was added, so that within ten days the cultures became liberally populated with these animals. One of the several species of eelworms that occurred in greatest number—a sharp-tailed species of *Rhabditis*[2] whose adult males, present in some abundance, were distinguished by a spicule of unusually large dimensions—then suffered mounting losses, and eventually the destruction of all motile individuals. Attack on a host nematode always proceeded from slender awl-shaped conidia that adhered to the integument. Early in the course of an epizootic within a plate culture, animals were most often found encumbered with one or, perhaps, two spores, but at later stages many eelworms could be seen moving about laden with a score of the tapering bodies (Fig. 1, *a-t*). Each conidium adhered by its narrower distal end, where it bore a slender process, mostly 2 to 5μ long, that was directed usually at a wide angle with the main axis. This slender apical process was always formed before the spore adhered, and for some little time following affixture was the only modification to be seen (Fig. 1, *a-c*). Fairly soon, however, the spore would intrude a delicate germ tube through the animal's integument, which on reaching the fleshy interior widened immediately to form a globose infection bladder (Fig. 1, *d-s*). Before long the conidium showed increasing vacuolization as its contents migrated gradually into the bladder, and finally its membranous envelope was wholly emptied of protoplasm. Thereupon, or sometimes a lit-

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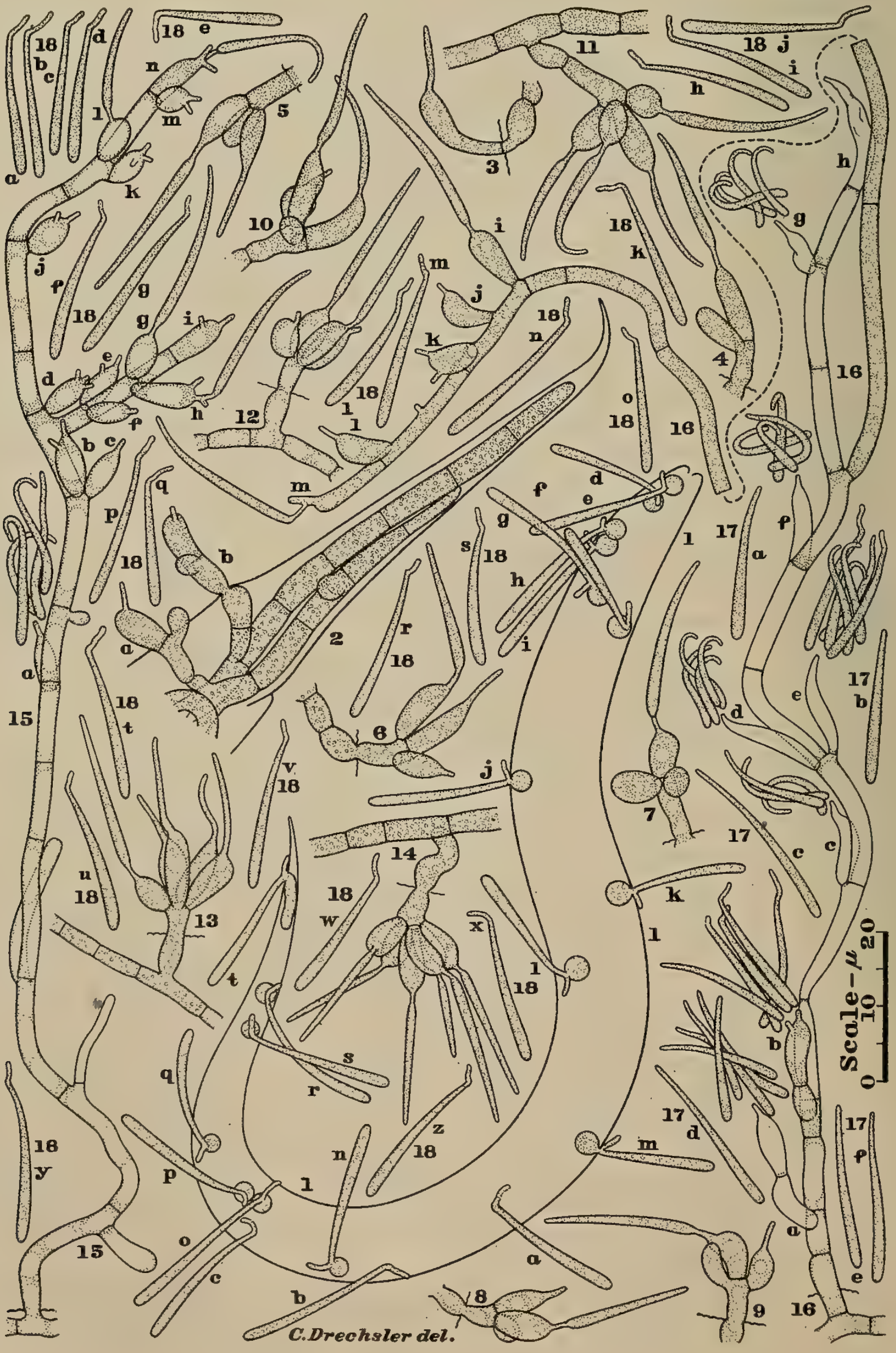
[1] Received October 18, 1950.

[2] For determination of this difficult eelworm I am indebted to Grace S. Cobb, Edna M. Buhrer, and Albert L. Taylor, all of the Division of Nematology, Bureau of Plant Industry, Soils, and Agricultural Engineering.

tle earlier (Fig. 1, *t*), the infection bladder began autonomous development by elongating as an assimilative hypha. The course of the growing hypha was marked by globulose degeneration of musculature and organs, with the usual unfortunate result that for a time the invading filament and all its branches were largely obscured from view.



FIGS. 1–18.—(See opposite page for legend).

Later, after the degenerating materials had mostly been absorbed, the assimilative hyphae, whether originating from single or plural infections, could be seen permeating the animal's interior somewhat uniformly from head to tail (Fig. 2). At this state they revealed cross-walls at moderate or rather short intervals, and the cells composing them were filled rather completely with protoplasm containing numerous granules. Subsequently as the animal's contents became further diminished, the continued withdrawal of substance necessary for the production of conidiophores and conidia was accompanied by increasing vacuolization, until finally the membranous envelopes of the assimilative hyphae, like the host integument surrounding them, were emptied of all protoplasmic residues.

The fungus always sporulates outside of the dead animal. Lateral branches are given off from scattered segments of the assimilative hyphae, and soon push their way out narrowly through the host integument (Fig. 2, *a*, *b*). Their external development is influenced markedly by the positional relationship of the dead eelworm in or on the infested material. If the animal host chanced to succumb on the surface, the lateral branch on erupting from the integument may at once give rise to an external cell that soon pushes up an apical protrusion (Fig. 3) which will develop into a sterigma and conidium. After one terminal conidiiferous cell, or phialide, has been delimited, usually through deposition of a cross-wall about 5μ outside the integument, a second phialide is often burgeoned forth laterally just below the first (Fig. 4). Other phialides may be produced, likewise in lateral positions directly below the first or terminal one, thereby giving rise to clusters of three (Figs. 5–9), four (Figs. 10–12), five (Fig. 13), and even six (Fig. 14). Dead host animals found on the surface of infested materials thus come to bristle with phialides in many places, and eventually the areas surrounding them are thickly bestrewn with detached conidia.

In instances where the infected eelworms happen to succumb in positions well under the surface of an agar plate culture, much rangier conidial apparatus is developed. Many of the branches here, on erupting from the host integument, do not give rise to phialides directly, but grow upward or ascendingly through the ambient, and on reaching the surface often elongate procumbently (Figs. 15, 16). The resulting filaments, which often exceed 100 or 200μ in length, and which soon become partitioned into cells mostly 5 to 15μ long, show some meager branching of ordinary character apart from the more abundant special type of branching entailed in their production of lateral phialides (Fig. 15, *a-h*, *j-m*; Fig. 16, *a-g*, *i-l*) from the distal end of many hyphal segments other than the terminal segments. The lateral phialides are produced singly or in two's immediately below the distal cross-wall, their plural production usually being less frequent in submerged positions (Fig. 16, *d*, *e*) than in positions on or above the surface (Fig. 15, *b*, *c; e*, *f; g*, *h; k*, *l*). In addition to the apical sterigma with which they are regularly provided, they often show one (Fig. 15, *b*, *e*, *j*, *m;* Fig. 16, *b*, *k*) or two (Fig. 15, *d*, *k*) sterig-

Figs. 1–18.—*Harposporium subuliforme*, sp. nov., drawn to a uniform magnification with the aid of a camera lucida, ×1000: 1, Small specimen of *Rhabditis* sp. to which are affixed 20 conidia, *a–t:* three of them, *a–c*, show only an adhesive spur at the apex; in 16, *d–s*, an infection bladder is present as well as an adhesive spur; in one, *t*, the infection bladder has begun to elongate into an assimilative hypha. 2, Tail end of a specimen of *Rhabditis* sp., showing interior of animal occupied by assimilative hyphae from which two reproductive hyphae, *a* and *b*, have been extended. 3, Short reproductive hypha terminating in a single phialide. 4, Short reproductive hypha with a full-grown terminal phialide and an incompletely developed lateral phialide. 5–9, Short reproductive hyphae, each with three phialides, full grown or in course of development. 10–12, Short reproductive hyphae, each with four phialides, full grown or in course of development. 13, Short reproductive hypha bearing five fully developed phialides. 14, Short reproductive hypha with six fully developed phialides. 15, Long reproductive hypha from an eelworm host that succumbed under agar; the proximal portion of the hypha whereon is borne one phialide, *a*, with its four abjointed conidia, is submerged, while the distal portion with 13 phialides, *b–n*, is partly procumbent and partly ascending. 16, Long reproductive hypha extended from a submerged animal host; the proximal portion of the hypha whereon are borne eight phialides, *a–h*, is submerged, so that the conidia formed on seven of these phialides, *a–g*, have remained clustered near the sterigmata; the five phialides, *i–m*, borne on the procumbent distal portion of the branch prolonging the hypha are denuded of their fully developed conidia. 17, Detached conidia, *a–d*, without adhesive spurs. 18, Abjointed conidia, *a–z*, each with an adhesive spur at its tip.

mata arising a short distance from the tip. Occasionally, besides, a sterigma may become branched (Fig. 15, *h*). The terminal hyphal segments here, as in related fungi, serve directly as phialides, and like the lateral cells of similar function, may have simple apical sterigmata (Fig. 16, *h*), branched sterigmata (Fig. 16, *m*), or plural sterigmata (Fig. 15, *i*, *n*).

The lateral phialide may rather correctly be described as flask-shaped, for with its usually elongated ellipsoidal venter, often two or three times longer than wide, and its slender though short sterigma, it offers much resemblance in outward form to some flasks of glass or metal that are widely familiar in our commerce. Only now and then is its venter so nearly globose that the shape of a Florence flask is approximated. As the Florence-flask type of lateral cell is strongly characteristic of *Harposporium anguillulae*, and occurs, besides, in the four congeneric species more recently made known, the present fungus might seem, if only the shape of its phialides were considered, less aptly referable to *Harposporium* than to *Acrostalagmus* or *Cephalosporium*. However, its conidia, when newly formed (Fig. 17, *a-d*), are slender awl-shaped bodies of dimensional proportions not usual in either of the two genera last mentioned. Wherever they develop undisturbed in submerged positions they form groups of four, or five, or six, at the tips of the individual phialides (Fig. 15, *a*; Fig. 16, *a-g*). In these groups they very often show pronounced curvature (Fig. 15, *a*; Fig. 16, *c*, *d*, *f*, *g*), and thereby come to resemble rather strongly the conidia of *H. anguillulae*. As a rule the conidia that have developed in the air, whether on phialides surmounting eelworms which succumbed in surface positions, or on phialides arising from procumbent or ascending prolongations of hyphae extended from dead animal under the surface (Fig. 15, *c-n*; Fig. 16, *i-m*), are larger and more nearly straight than those of submerged origin. Soon after they have been cut off, the conidia very commonly will grow out obliquely at the tip to form the delicate process (Fig. 18, *a-z*) by means of which they adhere to suitable roving eelworms. In respect to this curious incipient germination, the fungus shows parallelism with the several clamp-bearing basidiomycetous forms of similar biological habit that have been made known as members of the genus *Nematoctonus* (*1*, pp. 773–780; *2*; *3*; *5*). More especially it appears comparable with my *N. tylosporus* (*1*) since its adhesive substance is not collected in a visible droplet. Development of the adhesive spur is here not accompanied, as in species of *Nematoctonus*, by partial evacuation of the conidium.

Presumably the fungus, like the species of *Harposporium* described earlier, is to be reckoned in the same series of interrelated clampless hyphomycetes to which belong the insectivorous as well as the nematode-destroying species of *Acrostalagmus* and *Cephalosporium*. A term having reference to its awl-shaped conidia may serve as an appropriately suggestive specific name.

Harposporium subuliforme, sp. nov. Mycelium nutritum ramosum, incoloratum, septatum, intra vermiculos nematoideos viventes evolutum, in cellulis plerumque 5–15μ et 2–3.8μ crassis constans. Hyphae fertiles extra animal emortuum evolutae, interdum in materia animal ambiente omnino immersae interdum omnino vel magnem partem procumbentes vel ascendentes, in axe simplices vel parum ramosae, saepius 5–300μ longae, in cellulis plerumque 5–25μ longis et 2–3μ crassis constantes, ex plerisque cellulis 1–5 ramulos conidiferos sursum ferentes; cellula terminali etiam ramulis conidiferis (phialis) vulgo lageniformibus, 5–12μ longis, 2.8–4.3μ crassis, supra in 1–3 sterigmata abeuntibus, saepe 4–6 conidia gignentibus; sterigmatibus simplicibus vel rarius ramosis, vulgo 1–2.5μ longis, 0.6–.8μ crassis, conidiis incoloratis, subuliformibus, 12–26μ longis, basi rotundatis, ibi 1–1.8μ crassis, prope apicem 0.4–0.6μ crassis, ex apice ramusculum glutinosum 2–5μ longum et circa 0.6μ crassum emittentibus.

Vermiculos nematoideos specie Rhabditis necans habitat in foliis caulisbusque graminum (Digitariae sanguinalis, Eleusinis indicae, Cynodontis dactyli, Setariae sp.) putrescentibus prope Beltsville, Maryland.

Assimilative mycelium colorless, branched, septate, growing within living nematodes, composed of cells mostly 5 to 15μ long and 2 to 3.8μ wide. Conidiophorous hyphae developed outside of dead host, sometimes immersed entirely in the surrounding material, sometimes in part or wholly procumbent or ascending, only rather little given to ordinary branching, often 5 to 300μ long, composed of cells mostly 5 to 25μ long and 2 to 3μ wide, the terminal cell regularly being conidiiferous, many of the other axial segments bearing 1 to 5 conidiiferous branches (phialides) distally; conidiiferous branches commonly flask-shaped, often 5 to 12μ long, 2.8 to 4.3μ wide, provided distally with 1 to 3 sterigmata on which collectively are often borne 4 to 6 conidia; sterigmata usually simple, occasionally branched, commonly 1 to 2.5μ long and 0.6 to 0.8μ wide; conidia colorless, awl-shaped, straight or curved, 12 to 26μ long, rounded at the base, proximally 1–1.8μ wide, distally often 0.4 to 0.6μ wide, soon putting forth obliquely from the tip an adhesive spur 2 to 5μ long and about 0.6μ wide.

Parasitic on a species of *Rhabditis*, it occurs in decaying leaves and stems of various grasses (*Digitaria sanguinalis*, *Eleusine indica*, *Cynodon dactylon*, and *Setaria* sp.) near Beltsville, Md

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ENTOMOLOGY.—*The Linnaean subgeneric names of* Gryllus (*Orthoptera*).[1] ASHLEY B. GURNEY, U. S. Bureau of Entomology and Plant Quarantine.

In 1758 Linnaeus established six subdivisions of the genus *Gryllus*,[2] and with the exception of *Bulla* all have come to have an important part in the development of nomenclature within the Orthoptera. Prior to 1936, when Opinion 124 of the International Commission on Zoological Nomenclature was issued, the Linnaean subdivisions of *Gryllus* were generally treated as if they had acquired subgeneric status in 1758, since they appear to have been proposed in a manner that fully justified such acceptance. In practice they were raised to genera, in the concept of modern workers, but Opinion 124 stated that under the International Rules the subdivisions of genera published by Linnaeus in 1758 were not to be accepted as of subgeneric value as of that date. This situation created uncertainties, not only regarding well-known generic names but involving two of the best known family names, Tettigoniidae and Acrididae, as well.

In view of the facts presented in the following paragraphs, in September 1948 I requested the International Commission on Zoological Nomenclature to accept *Tettigonia* Linnaeus and *Acrida* Linnaeus as of subgeneric value as from 1758, under Suspension of the Rules, and to add them to the Official List of Generic Names in Zoology with type species as follows:

Tettigonia Linnaeus—type, *Gryllus viridissimus* Linnaeus, 1758.

Acrida Linnaeus—type, *Gryllus turritus* Linnaeus, 1758.

It is to be hoped that workers having opinions or additional information concerning the Linnaean subdivisions of *Gryllus* will communicate with the International Commission. In this manner all viewpoints and available evidence will be before the Commission, thus permitting a settlement in the best interests of stability and uniformity.

1. TETTIGONIA

Tettigonia is one of six subdivisions[3] of

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[1] Received September 22, 1950.

[2] The Linnaean subgeneric names of *Phalaena* (Lepidoptera) have recently been discussed in detail by Franclemont, 1950 (Journ. New York Ent. Soc. **58**: 41–53), and the principles presented therein likewise apply to the subgeneric names of *Gryllus*, although prior to the issuance of Opinion 124, in the former case, the genus (*Phalaena*) had been suppressed in practice in favor of the subdivisions (*Geometra*, *Noctua*, etc.).

[3] Regarding the other subdivisions of *Gryllus* Linnaeus, 1758, *Locusta* was added to the Official

Gryllus recognized by Linnaeus, 1758, and used by him in a sense corresponding to subgenera of modern workers. Although invalidated as of 1758 by Opinion 124 (1936), most taxonomic workers in the Orthoptera use the generic name *Tettigonia* Linnaeus, and the great majority of taxonomists and general entomologists utilize the orthopterous name Tettigoniidae.[4] This family name dates from the supergeneric group Tettigoniae of Stoll, 1787 (Spectres, Mantes, etc., **1:** Amsterdam), which was given the now accepted family ending -idae by Krauss, 1902 (Zool. Anz. **25:** 538). The only other family names that have been widely used in the same sense are Locustidae and Phasgonuridae.[5] The former is obviously unavailable here because *Locusta* is restricted to another family by Opinion 158 (1945). The name Phasgonuridae dates from Kirby, 1891 (Trans. Ent. Soc. London 1891: 405) but has been used less generally than Tettigoniidae, and in recent years relatively little, partly because of the assumption by many workers that *Phasgonura* Stephens, 1835 (Ill. Brit. Ent., Mand., **6:** 15) (type: *Gryllus viridissimus* Linnaeus), is a synonym of *Tettigonia* Linnaeus, 1758 (see discussion of genotypes below). Validation of *Tettigonia* Linnaeus would permit the continued general use of the family name Tettigoniidae, thus avoiding further confusion in the nomenclature of an order the family names of which were formerly subject to frequent changes but which in recent years have gradually become more standardized. The practice of working orthopterists indicates the desirability of validating *Tettigonia* Linnaeus.

Until the recent action of the International Commission with respect to names proposed by Geoffroy, 1762 (Hist. des insects **1:** 429), in Homoptera, *Tetigonia* Geoffroy, 1762, appeared valid if *Tettigonia* Linnaeus, 1758 (Orthoptera), were to remain invalid. Since *Tetigonia* Geoffroy had priority over *Ledra* Fabricius, 1803 (Syst. Rhyng.: 24), which name had been in general use until very recently,[6] the use of *Tetigonia* Geoffroy appeared necessary. It was thought, therefore, that confusion in the nomenclature of that group would be lessened if *Tetigonia* Geoffroy were rejected as a homonym

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List under Opinion 158 (1945); *Bulla* was suppressed as a homonym of *Bulla* Linnaeus, 1758 (Syst. Nat., ed. 10: 725) (Mollusca) under the amendment to Article 34 of the International Code adopted at Padua, 1930 (referred to in Opinion 124, 1936); *Mantis*, as of 1767 (Syst. Nat., ed. 12: 689), was added to the Official List under Opinion 149 (1943). For a time it appeared that *Mantes* Geoffroy, 1762 (Hist. des insectes **1:** 399), might have a bearing on the usage of *Mantis* Linnaeus, 1767, but the status of the Geoffroy publication has recently been studied by the International Commission, and the names there proposed have been ruled as unavailable except by use of the plenary powers (Heming, 1945, Bull. Zool. Nomcl. **1** (5): 117; 1950, ibid. **4** (13/15): 366–369). (Linnaeus, 1767, used *Mantis* in a generic sense, *Acrida* and *Acheta* in a subgeneric sense.)

[4] The general use of Tettigoniidae and Acrididae is evidenced by the utilization of these family names in the volumes of Zoological Record since 1922 (28 years). Both are the names currently used by the Bureau of Entomology and Plant Quarantine, in the United States, and the Commonwealth Institute of Entomology, for the British Commonwealth. The guidance in systematic entomology and the large number of routine identifications furnished by these two organizations constitute a great influence on the nomenclatorial usage of entomologists as a whole. Specialists in three outstanding centers of systematic work on Orthoptera, namely, London, Philadelphia, and Paris, use the above family names. They also appear in the handbook *Locusts and Grasshoppers*, published by B. P. Uvarov in 1928 and familiar to nearly all economic workers on grasshoppers.

Acrididae is the family name used in correspondence from the Anti-Locust Research Centre, in London, which organization is now coordinating most of the international work on large-scale grasshopper control and research.

Finally, a survey of published work by leading orthopterists throughout the world during the past 20 years shows that the preponderance of usage favors the family names Tettigoniidae and Acrididae. The following workers are among those whose publications were consulted and who have used these family names: J. A. G. Rehn, J. W. H. Rehn, M. Hebard, T. H. Hubbell, H. R. Roberts, B. B. Fulton, E. R. Tinkham, I. J. Cantrall, (U. S. A.); C. Bolivar (Mexico); J. Liebermann (Argentina); B. P. Uvarov, F. E. Zeuner (England); L. Chopard (France); K. Ander (Sweden); R. Ebner (Austria); W. Ramme (Germany); C. Willemse (Netherlands).

[5] Although the Rules are definite on certain aspects of family names, there is need for further clarification. (See Sabrosky, 1947, Amer. Nat. **81:** 153–160.) (Articles 4 and 5 of the International Rules of Zoological Nomenclature and Opinions 133 (1936) and 141 (1943) of the International Commission on Zoological Nomenclature concern family names.)

[6] China and Fennah, 1946 (Ann. Mag. Nat. Hist. (11) **12:** 707–712, 1945) pointed out the necessity of using *Tetigonia* Geoffroy, 1762, under rules then existing, and recognized that under paragraph 1d of Opinion 147 (1943) the slight difference in spelling (one or two t's) in Linnaeus' and Geoffroy's names permits only one name to be valid.

through the validation of *Tettigonia* Linnaeus, 1758. Thus, the validation of *Tettigonia* Linnaeus would clarify the nomenclature of two groups. However, if the Geoffroy names are to be considered unavailable (1950, Bull. Zool. Nomcl. **4** (13/15): 366–369), validation of *Tettigonia* Linnaeus would no longer be an advantage to the nomenclature of the Homoptera.

There are differences of opinion concerning the genotype of *Tettigonia* Linnaeus, and in the event of *Tettigonia* being validated it is important that the type be fixed beyond further argument. Suspension of the Rules may be necessary to fix that genotype which will create least confusion in the nomenclature of the Orthoptera. The majority of current workers accept *Gryllus viridissimus* Linnaeus as genotype, but I agree with Roberts, 1941 (Trans. Amer. Ent. Soc. **67:** 30–31), that the first valid designation was that of Kirby, 1890 (Sci. Proc. Roy. Dublin Soc. **6:** 481), *Gryllus verrucivorus* Linnaeus. If the latter designation is followed, as should be done under a strict interpretation of the Rules, the genus *Decticus* Serville, 1831 (Ann. Sci. Nat. **22:** 159) (type: *Gryllus verrucivorus* Linnaeus) will fall as a synonym of *Tettigonia* Linnaeus, at the same time invalidating the well-known subfamily name Decticinae.

Uvarov, 1923 (Trans. Ent. Soc. Lond. 1923: 493), and others have considered that Leach, 1815 (Edinburgh Encyclopedia: 120), designated *Gryllus viridissimus* Linnaeus as type of *Tettigonia*. Since Leach merely listed the species with no indication of type significance that I have discovered, type designation is not evident. Karny, 1908 (Zool. Annalen, Zeit. für Ges. Zool. **2:** 202–208), has argued that *viridissimus* became the genotype through the removal of all the other 16 species originally placed in *Tettigonia* by Linnaeus, 1758. Although selection of genotypes by elimination was once an accepted practice, it is believed to have no standing under present rules except in the case of a genus containing two species when one is removed to be type of another (Opinion 6, 1910) (also see Opinion 62, 1914). Rehn, 1901 (Can. Ent. **33:** 121), also reasoned by the method of elimination that *viridissimus* is type of *Tettigonia*, but his conclusion is so definite that it clearly constitutes type designation, the first clear-cut designation of that species, regardless of the reasoning involved.

Kirby, 1890 (l.c.), reviewed the originally included species of *Tettigonia* Linnaeus and by the method of elimination concluded that *verrucivorus* should be type. (Quotation from Kirby: ". . . which leaves *G. verrucivorus* as the type of Tettigonia.") Though not accepting Kirby's method of arriving at a conclusion on the type of *Tettigonia*, I believe, however, that his concluding statement, quoted above, constitutes type designation, irrespective of the method used in reaching that conclusion.

In the interest of nomenclatorial stability, it appears advisable to fix *Gryllus viridissimus* Linnaeus as genotype of *Tettigonia* Linnaeus, 1758, either under Suspension of Rules, or by ruling Kirby's designation invalid.

2. Acrida

Acrida is the second subdivision of *Gryllus* recognized by Linnaeus, 1758. It is of prime importance as the basis of the family name Acrididae, and since the acridids include a very large number of highly economic locusts and short-horned grasshoppers, it is very desirable that stability of the family name be achieved. A great majority of both systematists and economic entomologists now use the name Acrididae,[4] which is derived from the supergeneric group *Acridites* of Latreille, 1825 (Fam. Nat. Régne Animal: 414–416). All other names for the family are unsatisfactory because they lack priority, have had only a small amount of usage, or because they have been applied to different zoological groups in a manner that leads to confusion. For example, the name Locustidae dates from the group Locustariae of Latreille, 1804 (Crust. insectes **12:** 127–136), but at that time it was applied to katydids or long-horned grasshoppers (the Tettigoniidae of most current usage). In 1829 (Brit. Insects: 301) Stephens applied Locustidae to grasshoppers and locusts for the first time, and it has recently been done by Comstock, 1930 (Introd. Ent.: 252), Essig, 1942 (College Ent.: 90), and several others, though Acrididae is used by most modern taxonomists.[5]

To add to the confusion, Comstock, 1930 (l.c.: 254), used Locustinae for the subfamily of "spine-throated locusts," though the genus *Locusta* is not included in that subfamily, actually belonging to the group usually called the Oedipodinae.

A family name based on *Acrydium* has also been used, but *Acrydium* has been almost universally[7] applied to the grouse-locusts (Tetrigidae), and so Acrydiidae would be confusing if applied to locusts and grasshoppers.

In order for *Acrida* to be available as a basis for the family name Acrididae, it appears necessary that it be dated from Linnaeus, as that generic name was not subsequently brought into general use by orthopterists until the time of Stal, 1873 (Rec. Orthopt. **1:** 88, 95–100). Between the time of Linnaeus and Stal, Kirby, 1825 (Zool. Journ. **1:** 432), and Curtis, 1825 (Brit. Ent. **2:** 82), applied the name *Acrida* to katydids rather than to short-horned grasshoppers (see Roberts, l.c.: 5) so that it becomes essential to establish the validity of *Acrida* L. 1758. Krauss, 1902 (Zool. Anz. **25:** 541), first designated a genotype of *Acrida* Linnaeus: *Gryllus turritus* Linnaeus, 1758. Dirsh, 1949 (Eos **25:** 15–47), has recently revised the western Palaearctic species of *Acrida*, but without commenting on the nomenclature of the genus itself.

3. ACHETA

Linnaeus's fourth subdivision, *Acheta*, includes the true crickets, which, of course, are exemplified by *Gryllus* itself, of which *Gryllus campestris* Linnaeus is type, selected by Latreille, 1810 (Crust. Arach. Insectes: 433) (Opinion 104, 1908). There was no subdivision bearing the name *Gryllus* corresponding to the typical subgenus in a modern sense. If the subdivision *Acheta* were to be construed as constituting only one genus or subgenus in the modern sense, then naturally the one for which a type was first designated would take precedence and the other would fall (Isogenotypic genera, Article 30, f, International Rules). In this case the designation of a type for *Gryllus* antedates that of a type for *Acheta*. That fact is not a critical one, however, because under existing interpretations of the rules (Opinion 124) *Acheta* was not at any time validly proposed by Linnaeus. Furthermore, the majority of modern workers consider *Gryllus domesticus* Linnaeus not congeneric with *Gryllus campestris* Linnaeus, so that another generic name is needed. In the belief that a new name was necessary, Uvarov, 1935 (Ann. Mag. Nat. Hist., ser. 10, **16:** 320), proposed the genus *Gryllulus*, with type *Gryllus domesticus* Linnaeus. As pointed out by Roberts, 1941 (Trans. Amer. Ent. Soc. **67:** 33), however, *Acheta* is available for use, dating from Fabricius, 1775 (Syst. Ent.: 279). The International Commission has agreed (1950, Bull. Zool. Nomcl. **4:** (10/12): 266–267) that names proposed by Linnaeus in any editions of the Systema Naturae or by Fabricius as "intermediate terms placed between the generic name and the trivial name of a species" are not to be treated as having acquired the status of subgeneric names. *Acheta* Fabricius, 1775, is clearly used in a generic sense, however, and so it is available, as already stated. Curtis, 1830 (Brit. Ent. **7:** 293), designated *Gryllus domesticus* Linnaeus as type of the genus "Acheta Fab., Lea., Sam.," this being the first valid designation, and it establishes *Acheta* in the same sense as formerly used dating from Linnaeus, 1758. Accordingly, *Gryllulus* Uvarov falls as a synonym, as Roberts has noted. There is already some recent precedent for the use of *Acheta*, since the two common species occurring in the United States, *Acheta domestica* Linnaeus and *Acheta assimilis* Fabricius, are both represented in the list of Common Names sponsored by the American Association of Economic Entomologists (Journ. Econ. Ent. **43:** 117, 1950).

No Suspension of Rules is necessary to validate the use of *Acheta* Fabricius, since its proposal and subsequent type designation, cited above, are perfectly valid. However, as Secretary Hemming of the International Commission has stated to me in correspondence, it would be desirable for *Acheta* Fabricius, 1775, with *Gryllus domesticus*, Linnaeus 1758, as type, to be added to the Official List of Generic Names in Zoology.

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[7] Roberts, 1941 (Trans. Amer. Ent. Soc. **67:** 24), has recently shown that contrary to the traditional orthopterological practice, *Acrydium* Geoffroy 1762 actually applies to a zoological unit included in the Acrididae rather than the Tetrigidae.

Karny, 1937 (Gen. Insectorum, fasc. 206, Gryllacrididae: 213), listed *Acheta* Fabricius, 1775 (nec. Linnaeus), as a synonym of *Schizodactylus* Brulle, 1835, but that is a misapplication of the name, since *Acheta* has priority. Furthermore, although *Gryllus monstrosus* Drury, 1773, the type of *Schizodactylus*, was included in *Acheta* by Fabricius, 1775 (Syst. Ent., Appendix: 826), no designation of *monstrosus* as type of *Acheta* prior to Curtis's designation of *domesticus* in 1830 has come to my attention. Accordingly, Karny's view is incorrect.

ZOOLOGY.—*A new species of phyllopod of the genus* Streptocephalus *from Mona Island, Puerto Rico.*[1] N. T. Mattox, College of Agriculture and Mechanic Arts, Mayagüez, Puerto Rico. (Communicated by Fenner A. Chace, Jr.)

During the course of biological investigations on Mona Island, Puerto Rico, several collections of an anostracan phyllopod were made. These animals were first observed, in temporary rain pools, on November 15, 1949, by Felix Iñigo, of the U. S. Fish and Wildlife Service, Mayagüez Branch. On April 14, 1950, Mr. Iñigo collected 15 males and 18 females, and June 8, 1950, a third collection containing 60 males and 80 females. On June 22, 1950, I collected 33 males and 66 females from a fourth pool in which these animals have been observed. Study of these animals indicated clearly that they represented an undescribed species of the genus *Streptocephalus*.

Mona Island, politically a part of Puerto Rico, lies on latitude 18°05′ N. and longitude 67°55′ W., approximately 48 miles west-southwest of Mayagüez, Puerto Rico, and 40 miles east-southeast of Punta Espada, Dominican Republic, of the Greater Antilles. The total area of the island is approximately 14,000 acres. The island is relatively flat forming a mesa, averaging about 200 feet above sea level, which rises directly from the sea except for a coastal plain on the southwest side of the island. This coastal plain comprises approximately 1,000 acres on which a rich flora is found. The upper mesa has very little soil over the Ponce limestone (Miocene), which supports a sparse vegetation. Specimens of *Streptocephalus* have been found in temporary rain pools on both the coastal plain and the upper mesa.

Genus **Streptocephalus** Baird

Streptocephalus antillensis, n. sp.

Figs. 1–5

Description.—The clasping second antennae of the male present definite specific characters. The basal segments of these antennae are coalesced and with a very short bilobed frontal appendage extending between their bases (Fig. 1). The basal portion is long, slender, and much wrinkled with an outgrowth process arising from the lateral surface of the basal third of this segment. The inner, median, surface is variously spined. The terminal segment, or so-called "scissors" or "hand," is very diagnostic. The internal shorter branch bears two processes at the base on the anterior surface (Fig. 2), the proximal one of these curves mediad, the distal process is more conspicuous, longer, and free from the appendage. The distal end of this inner branch is curved ventrally and terminates in a rounded bilobed apex (Fig. 2 at *a*). The external branch of the "scissors" is proportionately much longer than that of other American species. The posterior, basal spur of this branch terminates in a distinctive "bird's head"-like form (Fig. 2, at *b*). The "elbow" angle of this branch is very short, while the distal part is greatly attenuated and variously spined, from 15 to 19 spines, on its anterior surface. This spination is very distinctive.

The head of the female possesses the typical two pairs of antennae without a frontal appendage. The second antennae are broad and shorter than the first and bear a few spines on the median distal surface (Fig. 3).

The swimming appendages are typical of the genus. The endopodite is terminally notched and the praeepipodite has a slight median notch (Fig. 4). Endites 3 and 4 have the typical two anterior setae and endite 5 the single seta.

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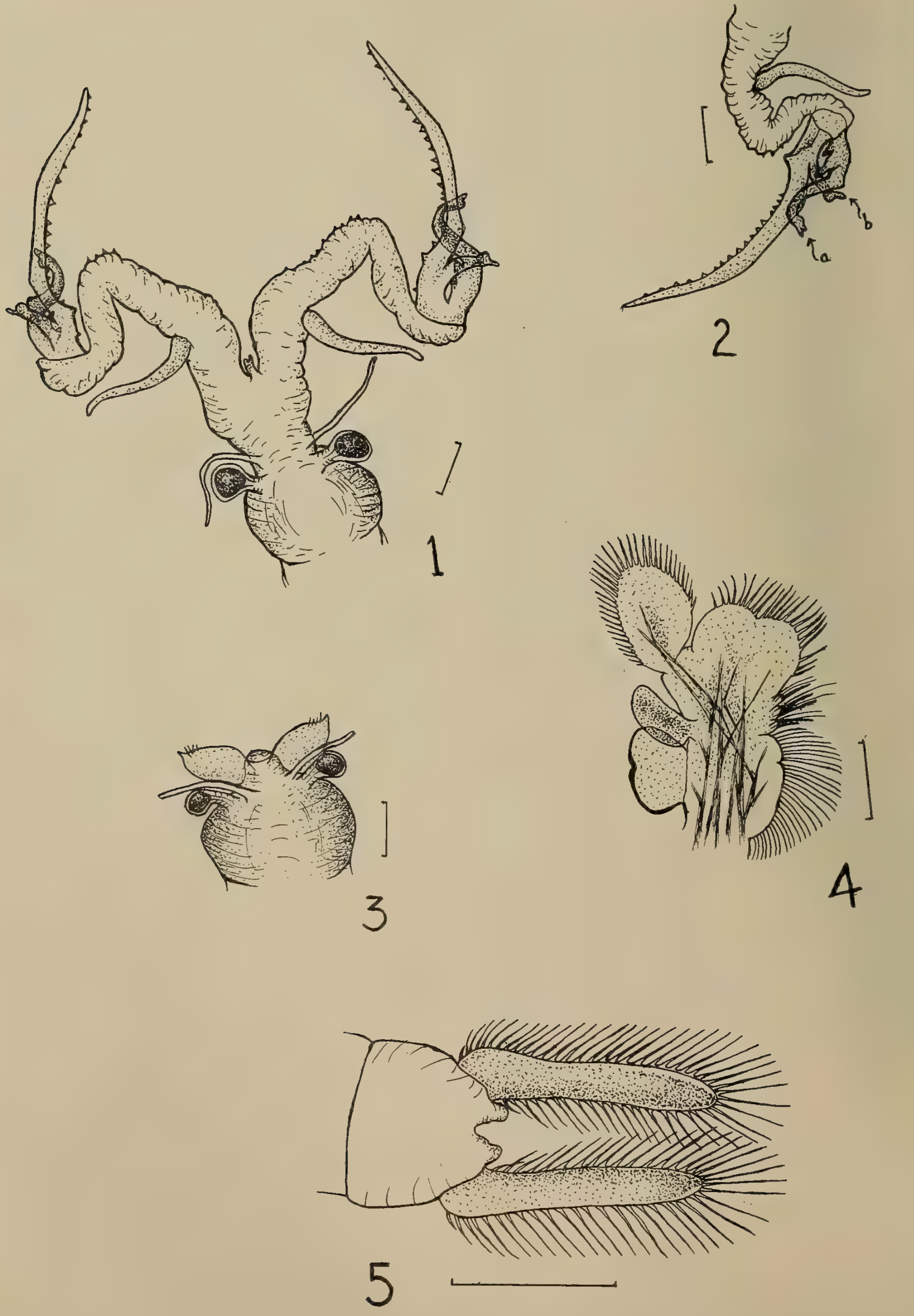
[1] Contribution from the Department of Biology, College of Agriculture and Mechanic Arts, Mayagüez, P. R. Received October 6, 1950.



Figs. 1–5.—1, Dorsal view of male head; 2, median view of second antenna of male; 3, dorsal view of head of female; 4, sixth swimming appendage of male; 5, dorsal view of male cercopods. (All camera-lucida outlines, scales equal 0.5 mm.)

The cercopods are distinctive. In both sexes the cercopods are heavily and regularly setiferous to the end. The cercopods are relatively short and lobeform and only slightly pointed (Fig. 5).

The penes possess a short, median process near the base. Terminally the penis has a short, heavy spine. The vas deferens has the characteristic dorsal loop without a seminal vesicle. The linguiform basal outgrowths mentioned by Linder (1941) are not present.

The maximum size observed for these animals is 11.0 mm in length. The average length for males is 9.9 mm and for females 9.0 mm. Specimens hatched in the laboratory from dried mud taken from a dried pool lived for 45 days and did not develop above average size.

Remarks.—*Streptocephalus antillensis* differs from the other western hemisphere species of the genus in many respects. Mackin (1942) indicates that the North American species prefer pools with abundant vegetation, while this species has been found in limestone pools devoid of vegetation except for some algae. In size this species is smaller than the other North American species: *S. sealii* Ryder up to 36.2 mm; *S. similis* Baird up to 15.5 mm, *S. texanus* Packard up to 29 mm, and *S. dorothae* Mackin up to 18 mm in length.

Through the courtesy of the U. S. National Museum I have examined specimens of *S. sealii* (U.S.N.M. No. 180642), *S. texanus* (U.S.N.M. No. 154820), and metatypes of *S. dorothae* (U.S. N.M. No. 79047). *S. antillensis* is easily separated from the species *S. sealii* and *S. similis* by the caudal furcae or cercopods, as in those two species the cercopods have heavy, curved spines distally instead of being setiferous to the end. Also *S. similis* has three processes on the anterior margin of the inner shorter branch of the male clasping antennae instead of the two processes of *S. antillensis*. *S. similis* has been recorded nearer, geographically, than any other species of the genus having been taken from Jamaica and the Dominican Republic. There seems to be a closer relationship between *S. texanus*, *S. dorothae* and *S. antillensis* than with the other two American species; the cercopods are similar, and the processes on the external branch of the clasping antennae are similar. However, the spinous and very elongated external branch of the "hand" and the "bird's head" termination of the basal spur are very distinctive, as are the shorter "elbow" section and general elongated proportions of this part. The more lobelike cercopods of *S. antillensis* also separate it from *S. texanus* and *S. dorothae* where the cercopods are more elongated and pointed. The presence of the spines on the elongated outer branch of the clasping antennae separates this species from all others of the genus except *S. dichotomus* Baird from India, *S. papillatus* Sars from Africa, and the varieties of *S. torvicornis* from Hungary, Egypt, and Morocco discussed by Daday (1910). These latter species are so distinctive in many respects that there is no chance of confusion with *S. antillensis*. The coalescence of the basal portions of the second antennae also seems to be a diagnostic character for this species.

Type locality.—Mona Island, Puerto Rico.

Types.—Holotype, male, U.S.N.M. no. 91085, and paratypes, both sexes, U.S.N.M. no. 91086, in the U. S. National Museum and in the writer's collection.

LITERATURE CITED

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LINDER, FOLKE. *Contributions to the morphology and the taxonomy of the Branchiopoda Anostraca.* Zool. Bid. Fran Uppsala **20**: 103–302. 1941.

MACKIN, J. G. *A new species of phyllopod crustacean from the southwestern short-grass prairies.* Proc. U. S. Nat. Mus. **92**: 33–39. 1942.

ORNITHOLOGY.—*The identity of the American vulture described as* Cathartes burrovianus *by Cassin.*[1] ALEXANDER WETMORE, Smithsonian Institution.

In the year 1845 on March 25 John Cassin presented before the Academy of Natural Sciences of Philadelphia the description of a species of American vulture based on a specimen forwarded from México by Dr. Marmaduke Burrough (then recently deceased), who had served as United States consul at the Gulf coast port of Vera Cruz. This bird, which Cassin believed to be new to science because of its small size and certain color and structural characters, he named *Cath-*

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[1] Received October 24, 1950.

artes burrovianus,[2] in honor of the collector "as a slight acknowledgment for his very valuable services to Natural History and to this Academy." The identity of this specimen remained uncertain for a good many years. Bowdler Sharpe[3] noted its resemblance to the species known in his day as *Cathartes* (or *Oenops*) *urubitinga* but was assured by Elliot and P. L. Sclater, who had seen the type in Philadelphia, that it was nothing but a small specimen of the common *Cathartes aura*. At the same time Sharpe gave the name *Oenops pernigra*[4] to a vulture from Brazil that he described as "entirely black, with purplish reflections . . . head yellow." Ridgway[5] considered *C. burrovianus*, which he called Burroughs's turkey vulture, the valid name for the yellow-headed species called currently *Cathartes urubutinga* Pelzeln,[6] supposedly a South American form, but from this conclusion given a range extending from Brazil to Veracruz, and questionably to Guanajuato (from data supplied by Professor Dugés). Sharpe[7] followed Ridgway's treatment of *burrovianus*, adding Guiana to the stated range, and included also as another species his *Cathartes perniger* (Sharpe) from "Guiana, Amazonia, Peru." Finally Nelson,[8] in a study of the North American turkey vultures, examined Cassin's type of *burrovianus* and concluded that it was a specimen of *Cathartes aura* Linnaeus, the type locality of which he designated as the state of Veracruz, a treatment of *burrovianus* that has been currently followed to the present time. There has been mention of these matters by other authors, but the above résumé covers the references pertinent to the present discussion.

For a good many years it has been apparent to me that the identification of the forms of turkey vultures from museum specimens is beset with many uncertainties. This impressed me particularly when I found that the skins of the yellow-headed species that I collected in northern Argentina and Paraguay in drying lost the distinctive head color so completely that it took close scrutiny to separate them from the red-headed forms. Further, there were difficulties in distinguishing the subspecies of *Cathartes aura*. Because of this I have given these birds special attention whenever possible, especially during work in the field in Central America and in northern South America.

In the dry season of 1948, with Watson M. Perrygo of the U. S. National Museum as assistant, I was in the field on the eastern side of the Azuero Peninsula on the Pacific coast of western Panamá, where we made as complete a collection of birds as time permitted. On March 17 we visited the Ciénaga Macana, near the small settlement of El Rincón in the northern section of the province of Herrera. While I waded waist deep in the lake for masked ducks, Perrygo devoted his attention to other species along the shore, at the same time watching to see that I did not get into trouble in the deep and sticky mud. Presently he shot three turkey vultures from birds that were circling overhead. I had noted from a distance that they appeared quite small and had supposed that they would be typical *aura*. It was a great surprise to find that the male, female, and immature male taken had the curious pattern of dull blue, dull green, and dull yellow on the head that marked them as the South American species, the yellow-headed vulture. We returned immediately to our quarters in Parita, where Richard Stewart, staff photographer of the National Geographic Society, another member of our party, recorded the head colors of our birds in kodachrome within an hour of their death.

These specimens led me to continue an intensive examination of skins of the genus in American museums, where to date I have seen nearly 400 specimens in our leading collections. At the Academy of Natural Sciences of Philadelphia one problem was solved when Rodolphe de Schauensee placed in my hands Cassin's type of *Cathartes burrovianus*, since it was evident at a glance that this was the same as the birds taken in western Panamá. It is planned eventually to summarize the growing amount of data on these birds assembled from museum material in a synopsis of all the forms of the genus. It seems desirable, however, to record the presence of the yellow-headed turkey vulture definitely in Central America and México that others may be warned to be on the lookout for it.

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[2] *Cathartes Burrovianus* Cassin, Proc. Acad. Nat. Sci. Philadelphia **2**: 212. 1845 (near Vera Cruz, Veracruz, México).

[3] Cat. Birds Brit. Mus. **1**: 28, 1874.

[4] *Oenops pernigra* Sharpe, Cat. Birds Brit. Mus. **1**: 26. 1874 ("north" = south side of the Rio Amazon, Brazil).

[5] Proc. U. S. Nat. Mus. **8**: 34–35. 1885; Man. North Amer. Birds: 221. 1887.

[6] *Cathartes urubutinga* Pelzeln, Sitzb. math.-naturw. Kl. Akad. Wiss. Wien **44**: 7. 1861. (Fortin do Rio Branco, Amazonas, Brazil).

[7] Hand-list Gen. Spec. Birds **1**: 240–241. 1899.

[8] Proc. Biol. Soc. Washington **18**: 124. Apr. 18, 1905.

The common name "yellow-headed" is valid for the bird in life, since when seen clearly in flight the head appears distinctly yellow, in contrast to the definitely red head of *Cathartes aura*. In the hand, however, other colors are evident. From an adult male that I shot at Las Palmas, Chaco, in northern Argentina on July 20, 1920, I wrote the following description from the freshly killed bird[9]:

> The bill was cream buff, shading to vinaceous buff on a broad area that extended onto the forehead, behind the nostrils; side of the head in general, including eyelids, deep chrome; center of crown dark Tyrian blue, bordered on either side by a broad band of stone green; skin of throat posteriorly deep chrome, becoming paler forward, to shade into olive buff toward base of bill; space between mandibular rami spotted with dark Tyrian blue; a dull spot of slate blue beneath the nostrils on either side; iris carmine; tarsus cartridge buff, shading to neutral gray on the toes, where the interscutal spaces have a scurfy whitish appearance.

From the most brilliantly colored of the three taken at El Rincón, Herrera, Panamá, in 1948, a female, I made the following notes in life: Cere, forepart of crown to center of eyes, nape, back of head, and throat dull orange-red; center of crown dull bluish gray; sides of head from posterior loral space through eye and ear, including the area down to below the gape, bright orange; lores greenish yellow; spot in front of and slightly above eye dull bluish gray; sides and front of neck, including the area covered by papillae dull yellowish orange; iris red. The other two taken at the same time were somewhat duller.

Foster Smith has furnished a sketch with a female shot at Cantaura, Anzoátegui, Venezuela, October 10, 1948, with colors marked as follows: Band across cere, extending down across base of mandible and back over forehead to level of eye, red; an irregular area on side of head covering auricular area and extending forward below eye dull dark orange; throat, foreneck, and sides of head in front off and above eye light blue with a greenish cast: posterior part of crown rather dark blue-gray; band across hindneck extending down posterior part of sides of neck light orange; iris dull red.

A sketch made by George K. Cherrie, of a female taken at Caicara, Bolívar, Venezuela, August 9, 1898, and preserved with the skin, catalogue no. 469920 in the American Museum of Natural History, gives the following data: Base of bill, throat, and upper foreneck dusky lavender-purple; cere and forehead pale creamy buff; space below eye ochre-yellow; posterior part of crown verditer blue; hindneck and sides of neck dusky orange-ochraceous.

In addition to the color of the head *Cathartes burrovianus* is marked by small but well-developed caruncles on the sides of the neck and at the base of the head. These are most evident in the adult but are slightly developed in immature individuals. The yellow-headed bird also is blacker, with few or no brownish edgings on the wing coverts. Northern specimens are small with tendency to increase in size from Brazil to northern Argentina. It is evident that two geographic races will be recognized when full information is available.

It is clear that the name for the yellow-headed turkey vulture becomes *Cathartes burrovianus* Cassin dating from 1845, with *Cathartes urubutinga* Pelzeln, 1861, and *Oenops pernigra* Sharpe, 1874, as synonyms. Should a southern subspecies be recognized it is probable that one or both of the two latter names may cover it. This may be determined certainly when further data are available.

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[9] Wetmore, U. S. Nat. Mus. Bull. **133:** 87. 1926.

MAMMALOGY.—*A new subspecies of harvest mouse (genus* Reithrodontomys*) from Chiapas, Mexico.*[1] EMMET T. HOOPER, University of Michigan Museum of Zoology. (Communicated by H. G. Deignan.)

In November 1948, Dr. H. O. Wagner collected seven specimens of *Reithrodontomys* at Cintalapa, Chipas, a locality that previously had not been sampled for harvest mice. Three of the seven are examples of *R. fulvescens chiapensis.* Four are examples of *R. mexicanus.* An analysis of variation in the species *mexicanus* was underway at the time the specimens were received. In manuscript I referred the four specimens of *R. mexicanus* to the race *howelli*, and entered the qualifying statement that "extreme pallor, small auditory bullae and long hard palate obtain in the examples from the lowlands near Cintalapa." In March 1950, Wagner obtained a small sample of *R. mexicanus* from Villa Flores, which lies 45 airline miles southeast of Cintalapa and also among the foothills of the Sierra Madre. Those specimens resemble the examples from Cintalapa. In the same set of characters the two series contrast with other samples of the species from México. They appear to represent a geographic race, heretofore undescribed.

Reithrodontomys mexicanus scansor, n. subsp.

Type.—Adult male, skin and skull; Univ. Mich. Mus. Zool. no. 96816; México, Chiapas, Villa Flores, elevation 2,000 feet; collected March 22, 1950, by Helmuth O. Wagner; original number 6023.

Distribution.—Interior arid tropical valleys in southwestern Chiapas. Known range from Cintalapa, 1,700 feet, southeast to Villa Flores, 2,000 feet.

Characters and comparisons.—A subspecies of *R. mexicanus* characterized by pale, vinaceous-tawny upperparts, small auditory bullae, and long hard palate. It differs from *mexicanus* in features as follows:

Smaller skull, well seen in the measurements of cranial length, zygomatic breadth, and length of molar row. Incisive foramina shorter and palate relatively longer (on the average the length of palate is 93 percent of length of incisive foramina in *scansor* and 81 percent in *mexicanus*). Fur of upper parts shorter and paler, with much less blackish overlay (of the guard hairs); cover hairs basally near Dark Plumbeous[2] rather than Plumbeous-Black; their distal bands paler (nearer Pinkish Cinnamon or Ochraceous-Tawny in subadult pelage and Orange-Cinnamon or Cinnamon in adult pelage, rather than Ochraceous-Tawny or Cinnamon in subadults and Tawny in adults of *mexicanus*).

Compared with *howelli*, *scansor* is paler and not as rufescent; the buffy bands appear slightly less rufescent in hue and the guard hairs either are fewer or are less blackish than in *howelli.* The auditory bullae are less inflated, the palate longer and the incisive foramina shorter (length of palate 93 per cent of length of foramina in *scansor* and 81 per cent in *howelli*). In the specimens of *scansor* the sphenopalatine vacuities are well-defined elongate slits. In most of the examples of *howelli* the vacuities are at best minute and irregular in outline.

Measurements.—Averages and extremes in millimeters of six specimens from Cintalapa and Villa Flores: total length, 180 (174–195); tail vertebrae, 105 (100–105); hind foot, 19 (18–21); ear measured from notch, 15, (15–16); greatest length of skull 22.7 (21.5–23.7); zygomatic breadth, 11.8 (11.4–12.3); breadth of brain case 11.1 (10.8–11.3); depth of cranium, 8.7 (8.4–9.0); interorbital breadth, 3.5 (3.4–3.7); breadth of rostrum, 4.2 (4.0–4.5); length of rostrum (measured from tip of nasal to notch, near lacrimal, on superior inner border of zygomatic process of maxilla), 7.6 (7.4–8.2); least breadth of zygomatic plate, 1.5 (1.4–1.7); length of palate, 3.8 (3.5–4.2); alveolar length of molar row, 3.3 (3.1–3.4); length of incisive foramina, 4.1 (3.9–4.2); breadth of mesopterygoid fossa, 1.5 (1.4–1.6).

Remarks.—*R. m. scansor* inhabits arid tropical lowlands in the rain shadow of the Sierra Madre. In Central America and Mexico the species *mexicanus* is found predominantly in moist subtropical and temperate highlands within the altitudinal range 4,000–7,000 feet. Where conditions are locally suitable it descends into arid tropical lowlands. Dr. Wagner informs me (*in*

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[1] Received September 14, 1950.

[2] Capitalized color terms from Ridgway, *Color standards and color nomenclature*, 1912.

litt.) that at Cintalapa and Villa Flores the species was found only near stream courses and in swampy areas. The species is known to be semiarboreal in habit. The scansorial tendency is evident in *scansor*. Seven of the nine specimens were trapped in trees, three in flowering *Erythrina*, and four in trees of undetermined kind. Another specimen was obtained under a clump of bushes and trees.

In coloration and other characters of the fur *scansor* resembles *R. pacificus*. In both the coloration of the upperparts is comparatively drab and "streaked" in appearance and the fur is short and coarse. All specimens of *pacificus* that I have seen are smaller than those of *scansor*, however; the smallness is well seen in the length of the hind foot, breadth of brain case, and length of molar row. The tail of *pacificus* is shorter, the interorbital diameter of the skull is relatively greater, and the rostrum is relatively broader. The external resemblances in those two forms appear to be responses to somewhat similar environments. Other characters of *scansor* suggest consanguinity with *R. mexicanus;* the form appears to be a geographic race of that species.

Specimens examined.—Nine from localities in Chiapas, Mexico, as follows: Cintalapa, 1,700 feet, 4; Villa Flores, 2,000 feet, 5.

PROCEEDINGS OF THE ACADEMY

440TH MEETING OF BOARD OF MANAGERS

The 440th meeting of the Board of Managers, held in the Cosmos Club, October 30, 1950, was called to order at 8:05 P.M., by the President, F. B. SILSBEE. Others present were: H. S. RAPPLEYE, H. A. REHDER, F. C. KRACEK, F. M. DEFANDORF, W. F. FOSHAG, C. L. GAZIN, H. P. BARSS, A. T. MCPHERSON, C. F. W. MUESEBECK, W. A. DAYTON, C. A. BETTS, E. W. PRICE, MARGARET PITTMAN, and, by invitation, R. G. BATES and T. D. STEWART.

At the request of the President, the Acting Secretary read the results of the ballot upon the amendment to article II, section 1, paragraph 3 of the bylaws increasing the number of permitted active members of the Academy from 750 to 1,000 and the resident members from 600 to 800, as follows:

In favor of the amendment	374
Opposed to the amendment	11
Not voting (returned ballot)	1
Unsigned (therefore not tabulated)	3
Total ballots received	389
Total membership canvassed	817

The Chairman of the Committee on Meetings, F. M. DEFANDORF, announced that J. A. VAN ALLEN would speak on researches on upper atmosphere at the next meeting of the Academy.

The Chairman of the Committee on Membership R. G. BATES, presented 24 nominations for resident membership and 2 for nonresident. Twenty-four persons previously nominated were elected to resident membership.

The Chairman of the Committee on Awards for Scientific Achievement, T. D. STEWART, announced that the subcommittees had not yet reported their recommendations. However, in view of the situation existing in the consideration by the subcommittee for Physical Sciences for their nominee, the Board was requested to consider the situation of a team of two individuals working on the same project and equally worthy. It was the feeling of the Board that, if this subcommittee proposed a team of two, the Board might be favorably inclined to suspend the Standing Rules for its consideration.

A. T. MCPHERSON introduced the following resolution, which was accepted by the Board, but no action was taken.

> Whereas it is stated in the Act of Incorporation of the Academy that the "particular business and objects are the promotion of science," be it resolved that an Award of the Academy be granted for Noteworthy Accomplishment in the Teaching of Science, and that this award be governed by the same conditions and limitations as the Academy Awards in the physical, biological, and engineering sciences, and be it further resolved that the present Committee on Awards be augmented as necessary in order to give consideration to nominations for an Award in the teaching of science for the current year.

The President announced that he had received a letter from L. W. PARR, Chairman of the Committee on Policy and Planning, regarding the activities of the Committee, past and present.

The Acting Secretary reported the following deaths: HOWARD S. REED, University of California, Berkeley, Calif., on May 12, 1950 (elected October 11, 1940); M. A. RAINES, Howard University, on July 1, 1950 (elected December 1, 1939); C. W. WARBURTON, formerly with the Farm Credit Administration, on September 22, 1950 (elected December 22, 1924; on retired list December 31, 1948).

EMANUEL G. ZIES was transferred to the retired list of members, effective December 31, 1950.

The Board approved a motion that $55 in addition to the $10 previously allotted in this year's budget be provided for continuation of the Science Calendar and directed that the Affiliated Societies be circularized for whatever they are willing to contribute toward the $65 requested.

The Senior Editor, FRANK C. KRACEK, read the following letter from Waverly Press, Inc.:

> October 18, 1950
>
> Dear Doctor Kracek:
>
> Waverly is an open shop but pays the same wage scale as local union shops, for obvious reasons. On October first a new union contract was signed which gives the workers a 10% increase in wages and we must follow suit.
>
> As much as we dislike to do so, it is necessary to ask your permission to increase by 10% the rates for the Journal, effective with the first issue scheduled for 1951.
>
> As in the past, we will continue to charge for paper on a cost plus basis. During World War II our paper needs were taken care of by the Mead Paper Company. This company has given assurance that sufficient paper will be provided for the Journal during the present emergency.
>
> I hope sincerely that this increase in rates will not be too upsetting to your publishing program. We have tried to give you as much advance notice as was possible.
>
> Sincerely yours,
> /s/ FRANCIS C. HARWOOD

No action was taken, the matter being referred to next year's Board to consider in its budget.

The meeting was adjourned at 9:50 P.M.

C. LEWIS GAZIN, *Acting Secretary.*

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  To January 1953......Howard P. Barss, A. T. McPherson
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